VAWT Report

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1- About the Study:

The aim of the study is to find the most efficient Vertical Axis Wind Turbine (VAWT) with the highest spinning speed and higher moment of rotation. For this, we have studied many types and configurations of the blades and the directors, and many combinations of them. Each study took long time in ANSYS from hours to 2-3 days. First, we have studied many configurations of the blades to find the best shape of the blades and turbine, after determining the best one, we moved to find the best suitable directors, and here we have tested the recommended directors and others we have suggested. Then, we have tested the combination of the turbine and directors to see the compatibility and decide the best configuration. Finally, we have built the final CAD design, and in final section of this report, we attached results and calculations of the study.

2- Designing the most Efficient Blades (Turbine):

We have studied the given reversed blades in the figure (1), and compared it with unreversed blades with closed center figure (2), and we find that the un-reversed blades gives higher Moment of rotation, figure (3).

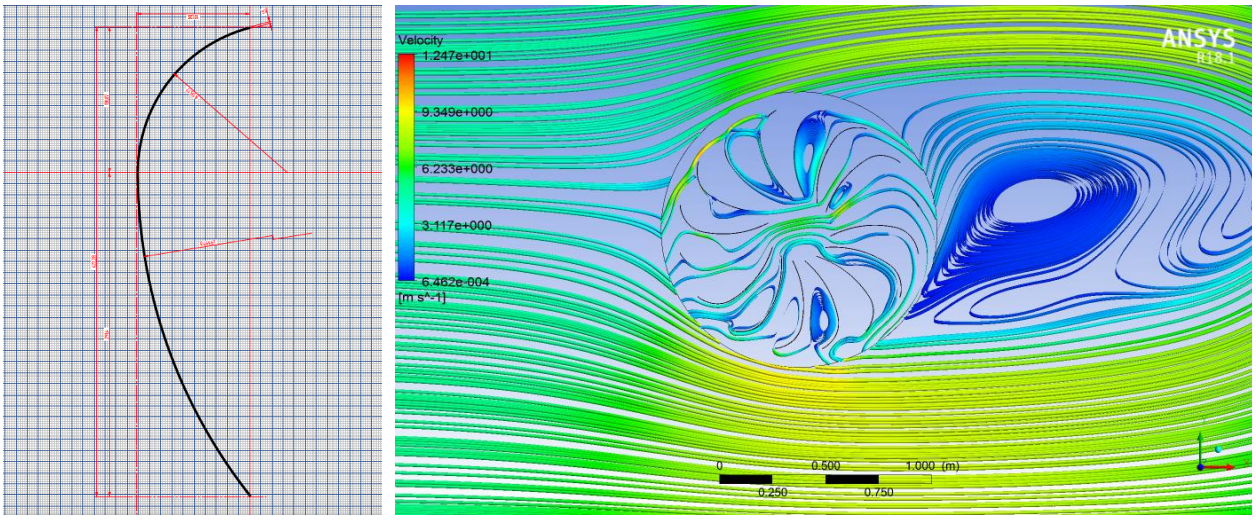


Figure (1) – reversed Blades

In addition, we find that the opening center decrease the speed of rotation when we have wend comes from multi direction. Therefore, we closed the center in the second model.

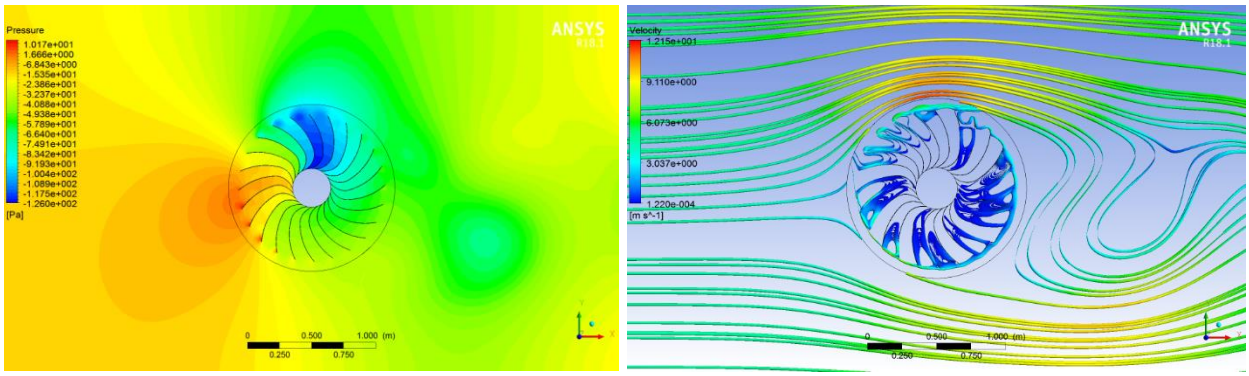


Figure (2) – un-reversed Blade Closed Center

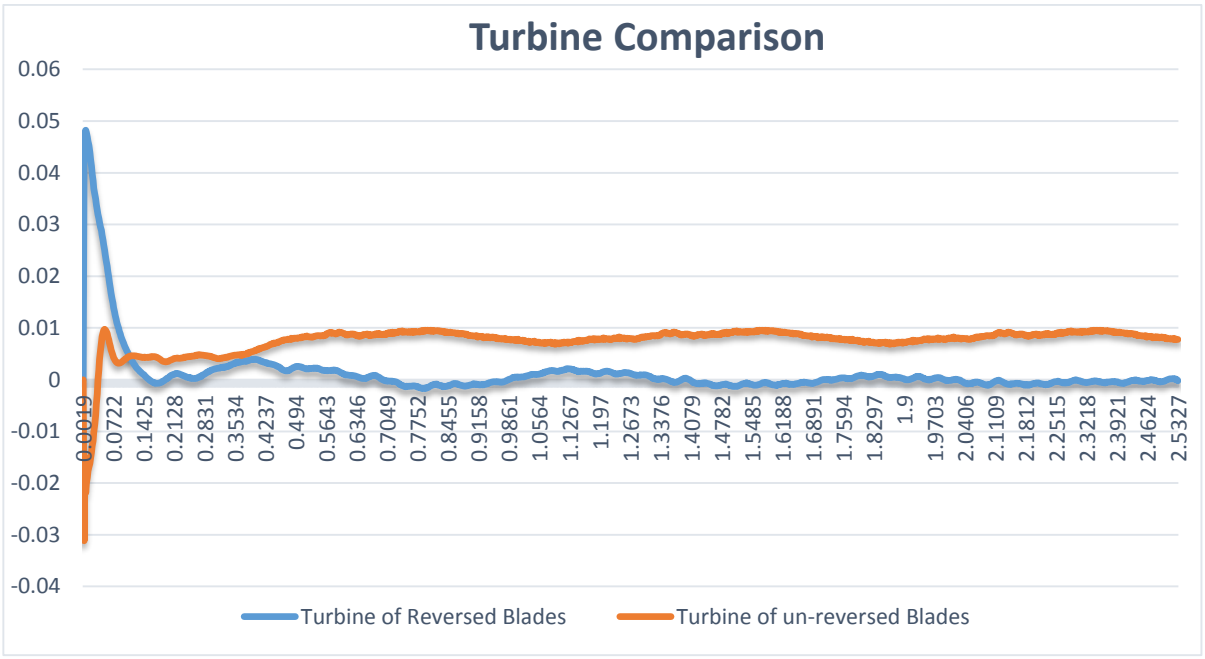


Figure (3) – Cm of the reversed and un reversed Blades

After that, we have suggested mixing between the open center wind turbine and closed center with un-reversed blades, the aim was to make the rear section of the turbine works, while in real turbines only the frontal section whose works where there are air hitting the blades and in the rear section there are not air hitting them. Therefore, we have designed a nozzle in the middle section of the turbine. The opening of the turbine always turns with the wind direction, and the end of the turbine throw compressed air on the rear section of the turbine. The study shows that the design gives higher moment of rotation and higher spinning, figure [4-7].

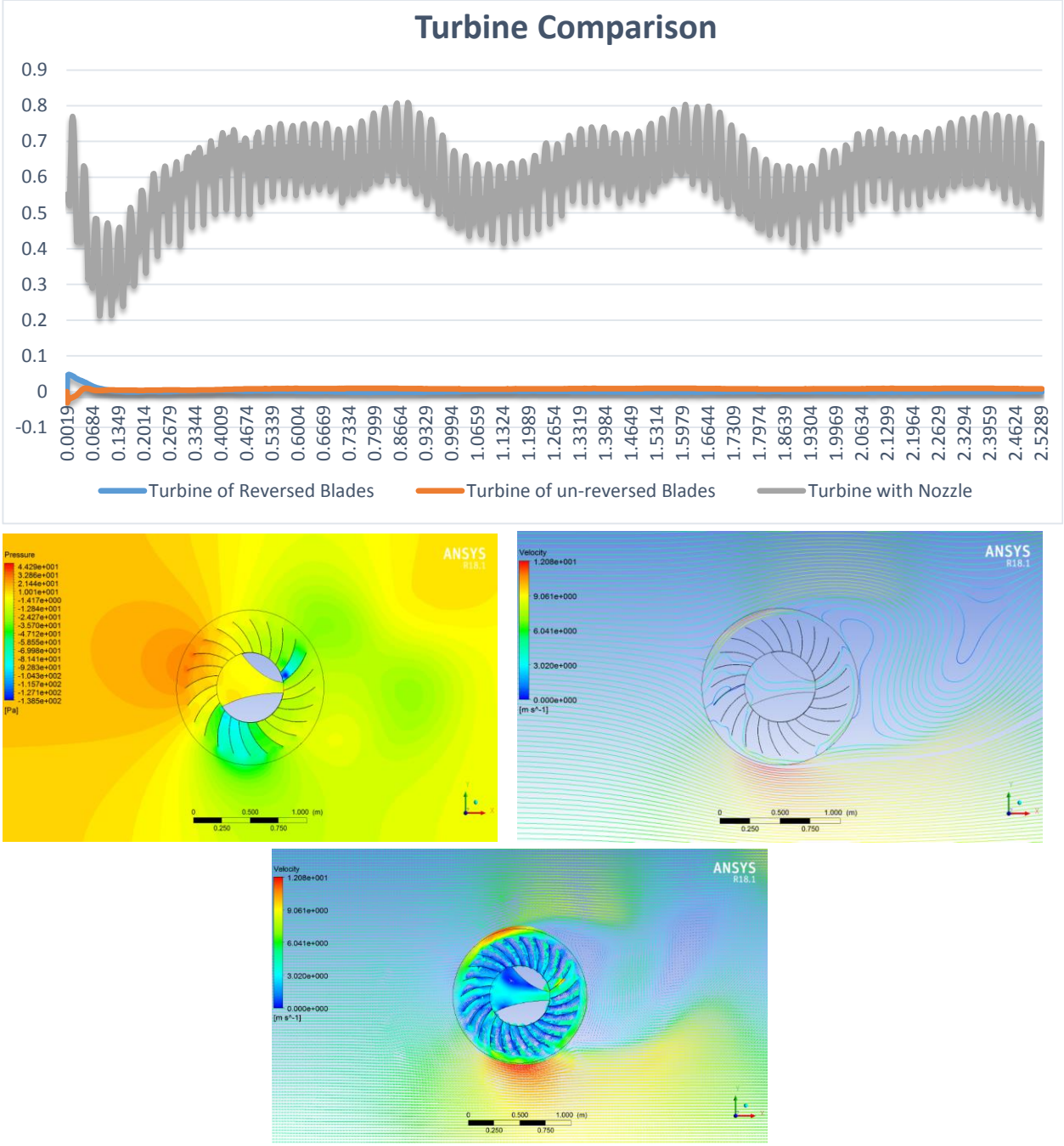


Figure [4-7] – Pressure, Velocity, Stream Lines and Cm of Turbine with Nozzle

We can see that the Moment is increased very much, and you can notice that we have cut the blades, because the inner section of them are not working and not giving efficiency comparing efficiency with the cost.

3- Designing the Directors:

The idea of the directors is to direct the flow and increase its velocity, therefore, we have tested the directors alone, and we have measured the velocity increase at the end of the diverged sections, and compared the various designs. There were multi-designs and configurations of the directors about three designs with about three configurations of each. An addition to the designs, have been suggested by you it is the 30 degree tilt base. The results shows that the tilt based increases the flow velocity by 1.61 times.

The first design of the directors is shown in figure (8), and in it, we can see that the turbine cannot breathe and the incoming flows have a trouble in finding the exit bath, this cause braking for the turbine, and I think it is not the best design. Rather than the streamlines enter the turbine in very elegant way and smoothly, but the moment was small.

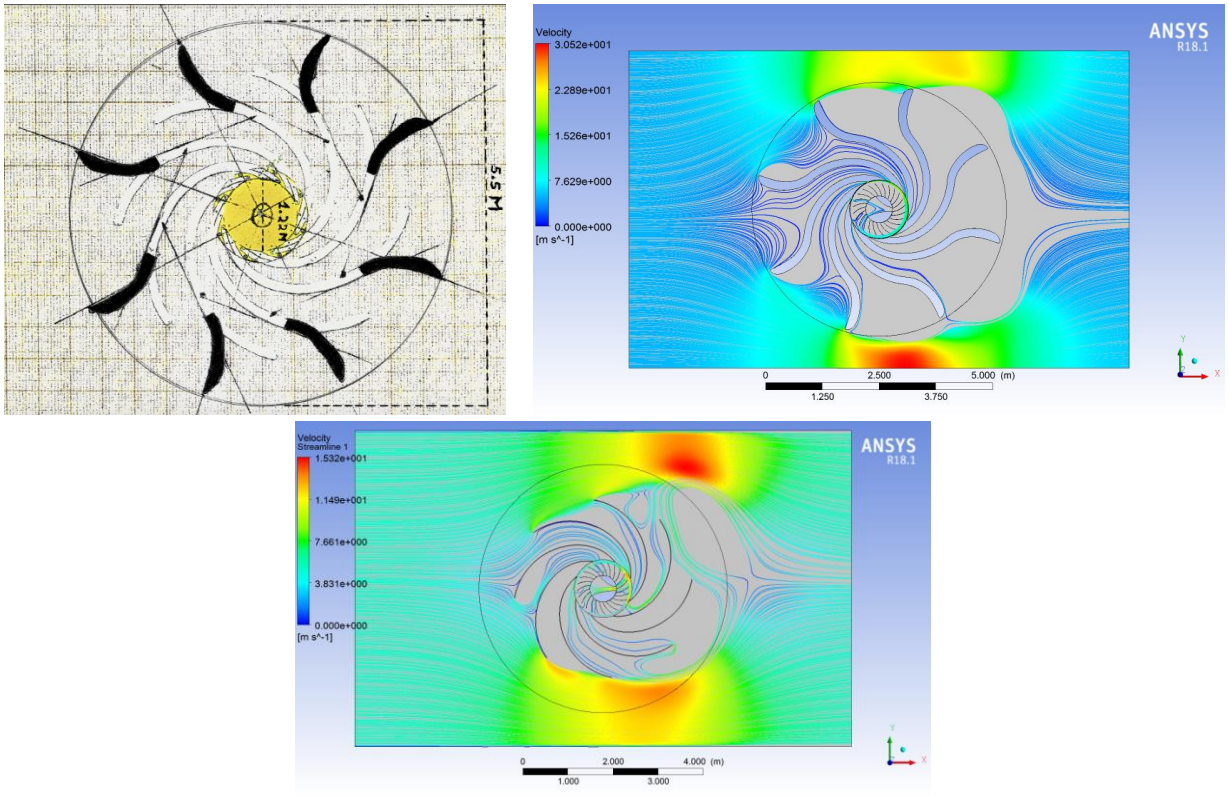
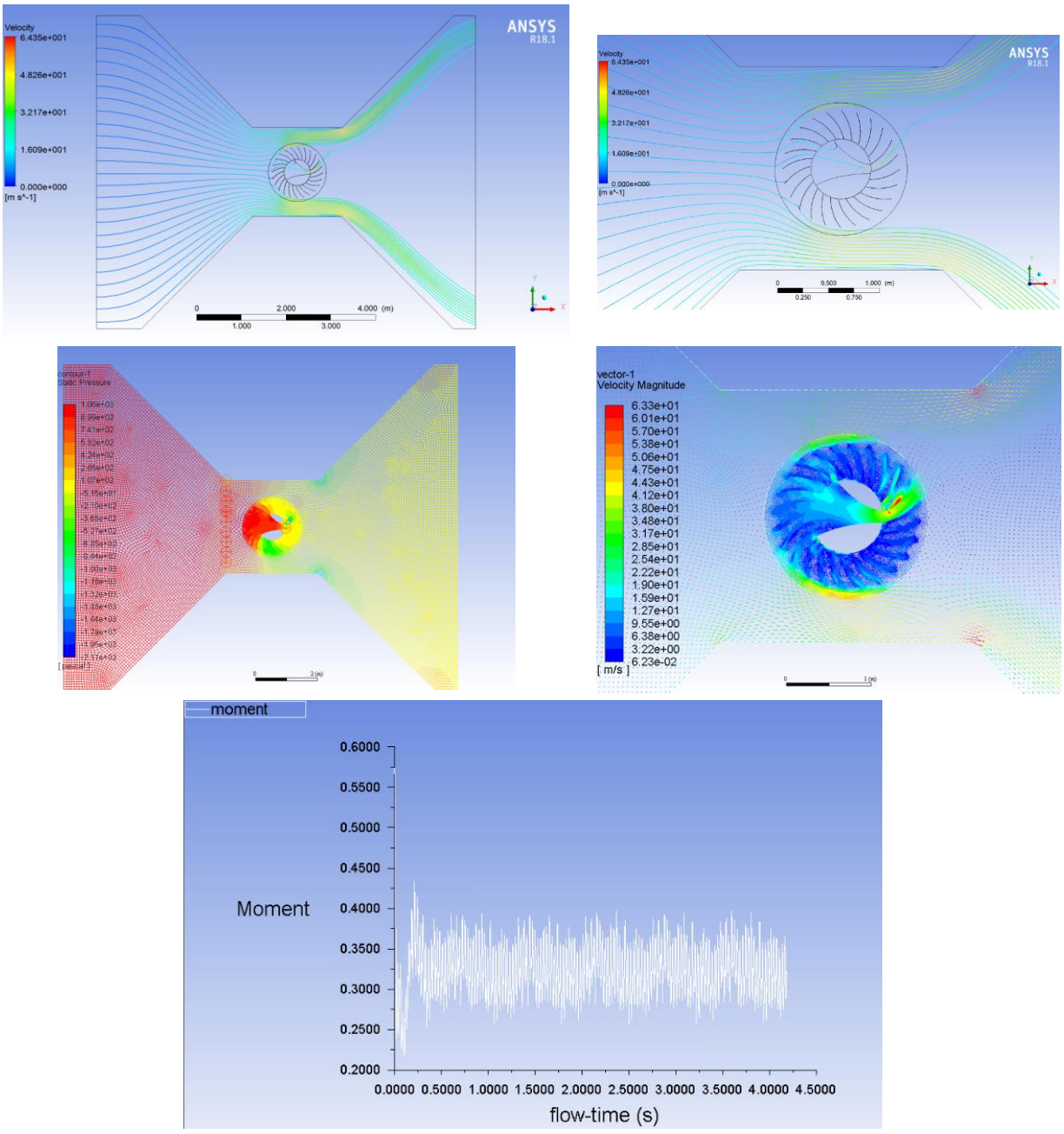


Figure (8) – First design of the directors

In the second design, the first configuration gave results that were better, and we have higher velocity compression, then higher moment, and in it the streamlines don't have problem to find the exit bath so less braking. See figures [9-13].



Figures [9-13] – Second design of the directors (Streamlines, Pressure, Velocity, Cm)

We can see that the moment less than the best design W/O directors, and the pressure at the front of the turbine high, so in un-expected wind

conditions, this might cause problems for the directors. So we have suggested to make the directors more than 4 and increase it to 6, but the moment decreased! As in the figures [14-15].

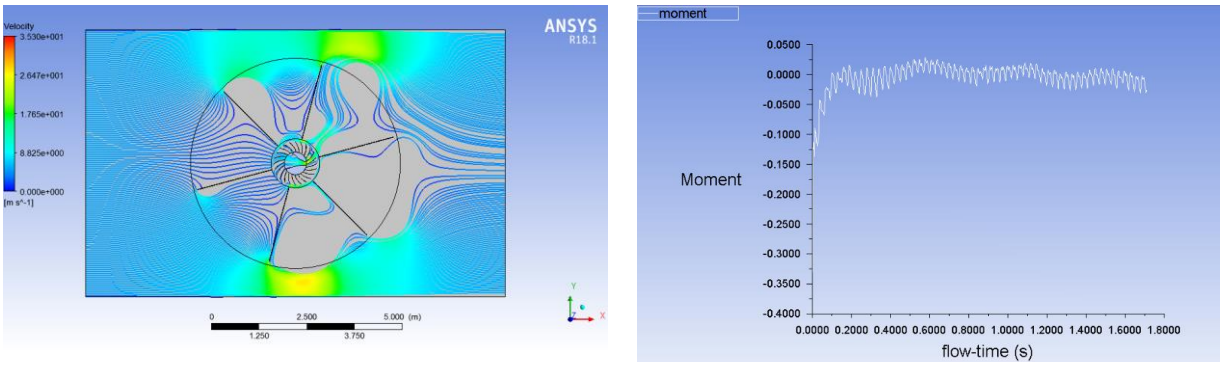


Figure [14-15] – The second design second configuration

We have increased the number of the blades further to 12 directors, and the results were better, but less than the first configuration. The moment increased, as so the velocity, see figures [16-17].

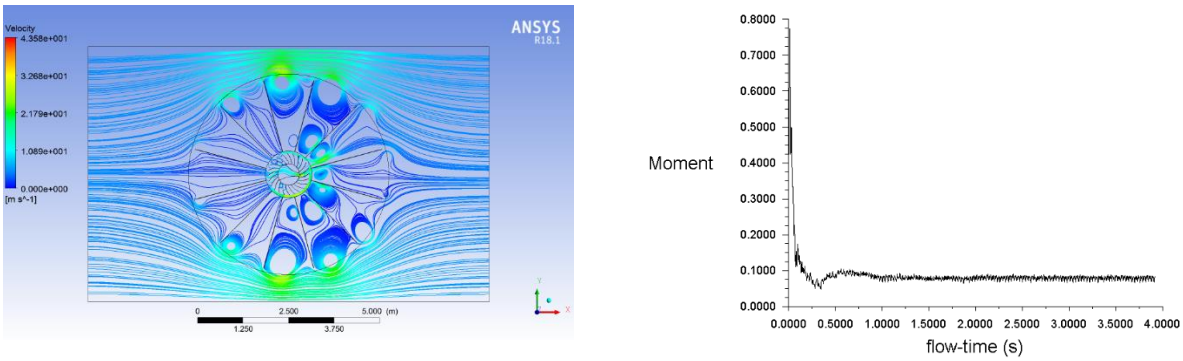


Figure [16-17] – second design of 12 directors

In figure (18), you can see the comparison among the directors of the second design and the final design W/O directors, and we can see that the final W/O directors is the best, so our work is a rubbish until now!

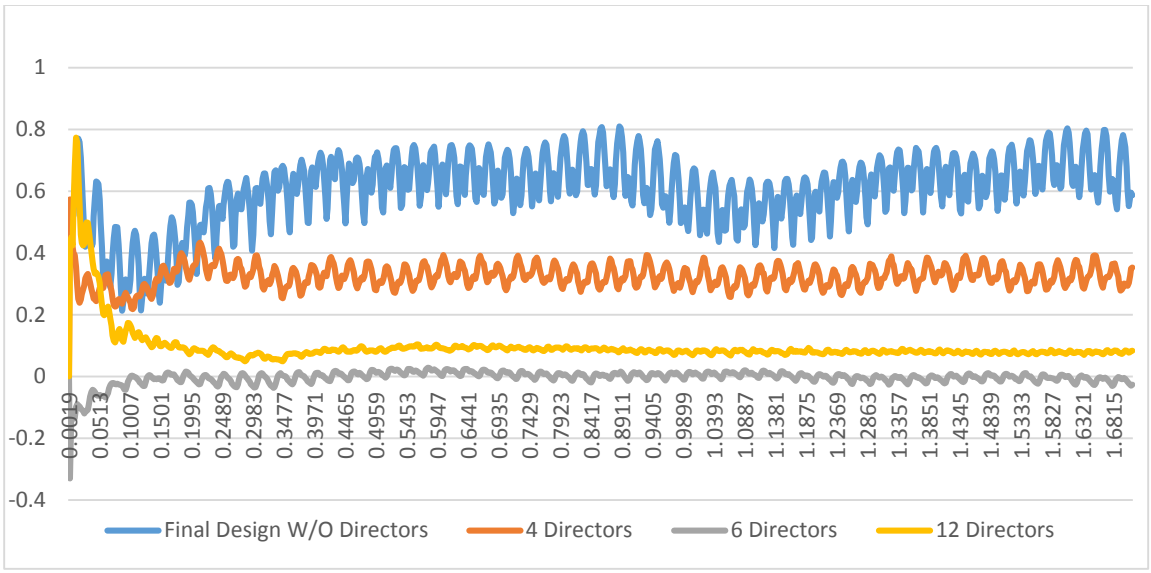
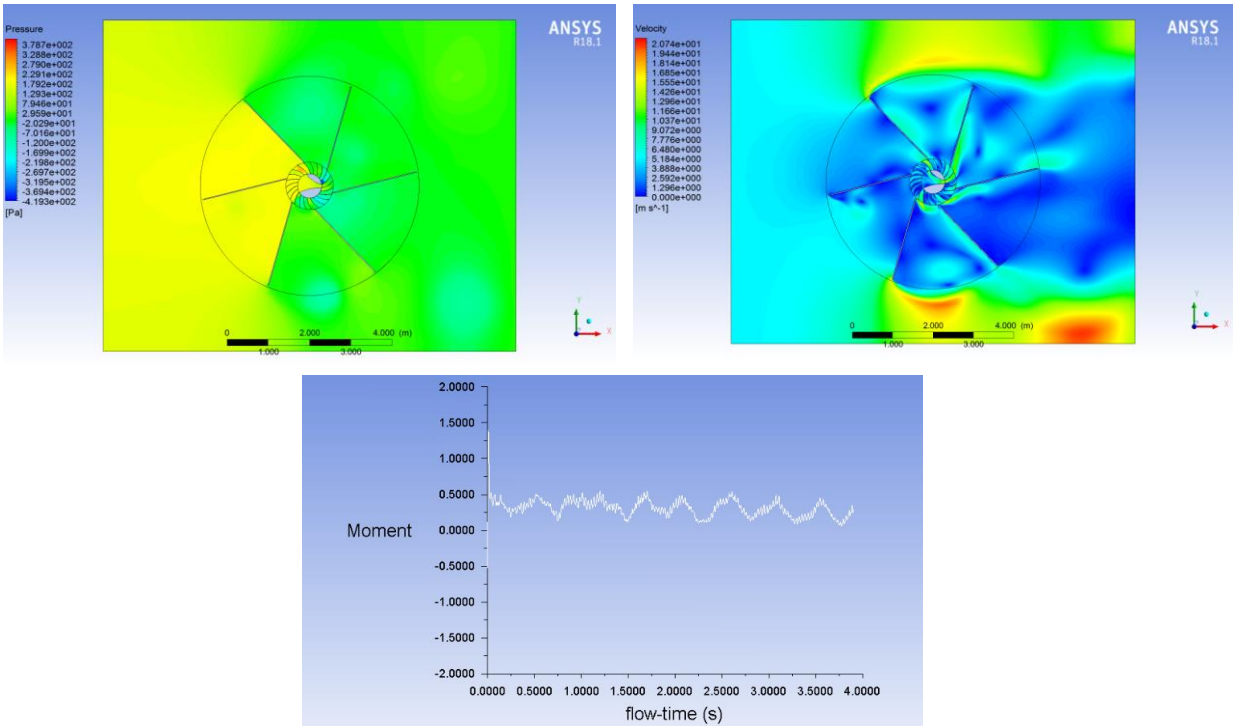


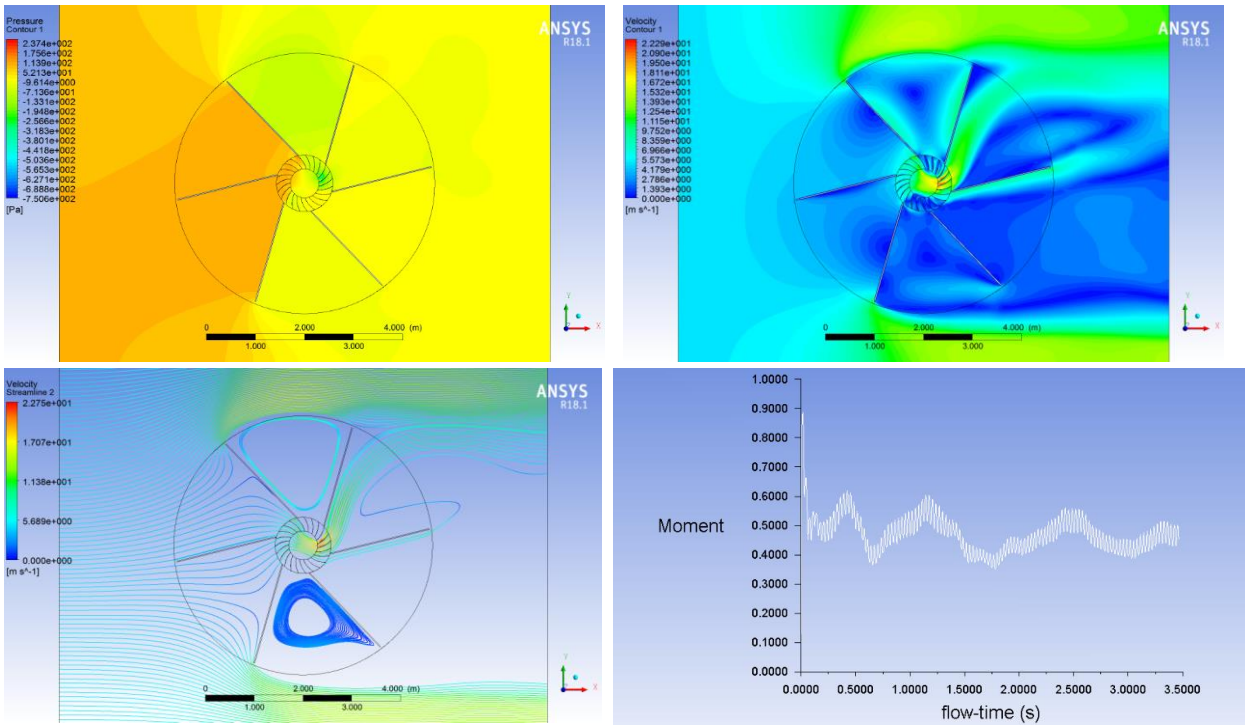
Figure [18] – Cm comparison for the second design

Finally, we decided to mix between the first design and the second design, so that, the flow enter the turbine softly and at the same time have no problems in finding the exit. Here also we have many configurations and different number of blades. In the first configuration, we have 6 directors. See



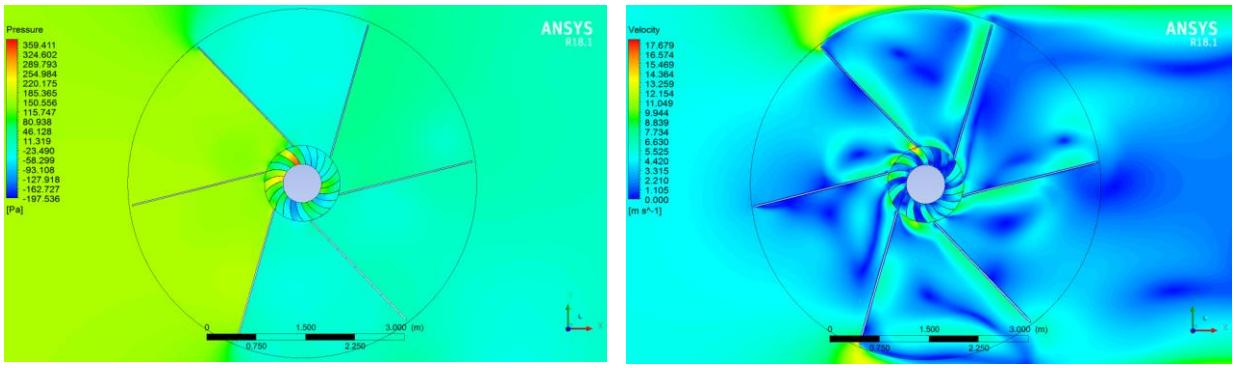
Figures [19-21] – Mixed design with 6 directors

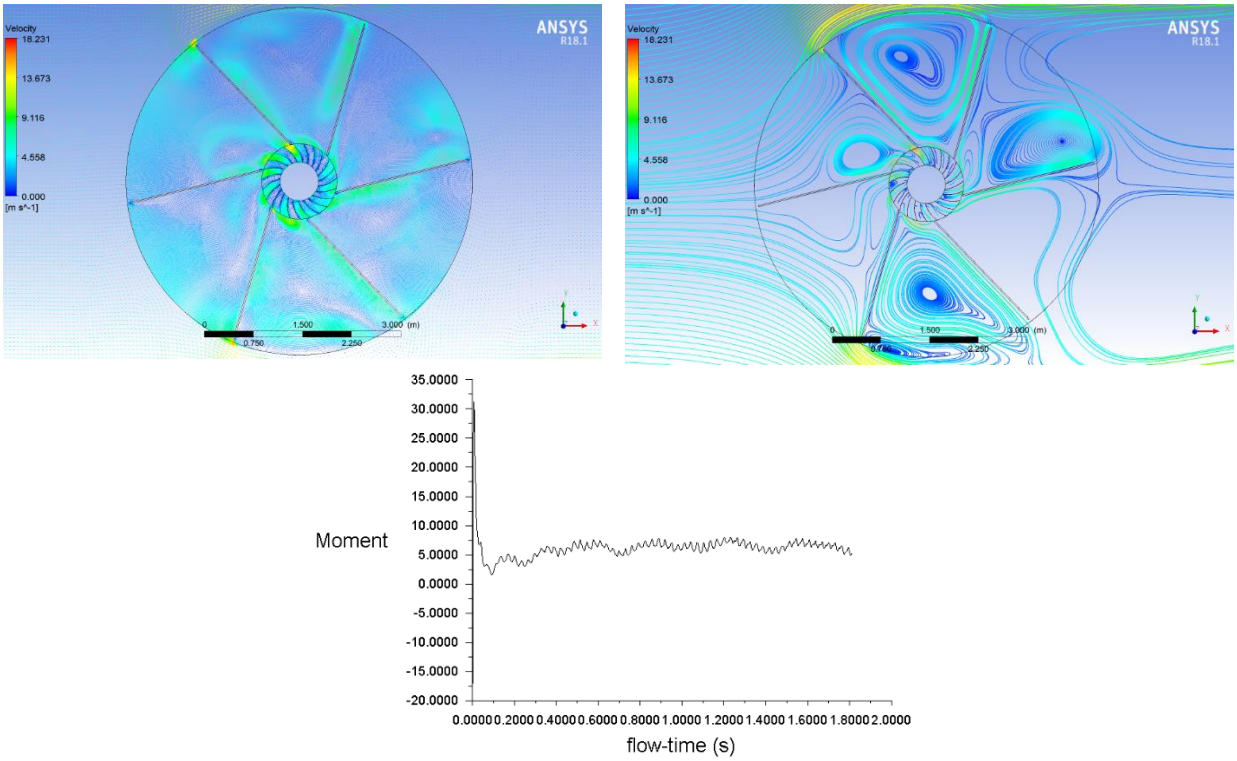
Figures [19-21]. We can see that the moment a little bit better. While this design is good, we decided to make a modification to the middle parts, so we deleted the nozzle and kept the middle opened, the results unexpectedly were better, see figures [22-25].



Figures [22-25] – Mixed design with 6 directors and opened center w/o nozzle

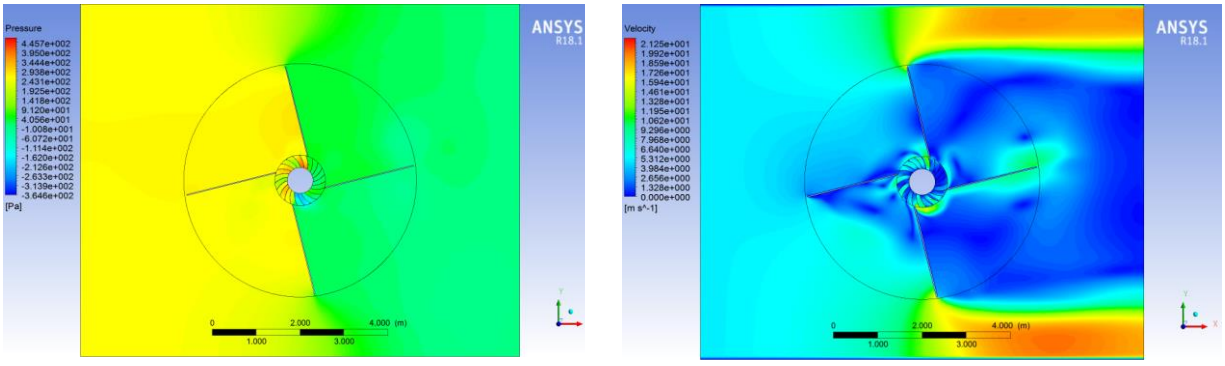
We can see that the results also better, and the velocity and moment increases, so we decided also to test another configuration with closed center, see figures [26-30]. The results were awesome, the moment jumped

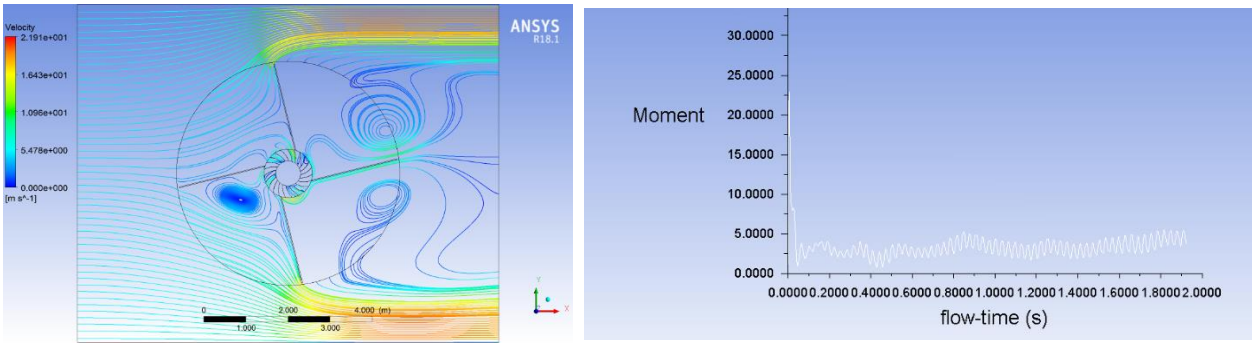




Figures [26-30] – Mixed design with 6 directors and closed center

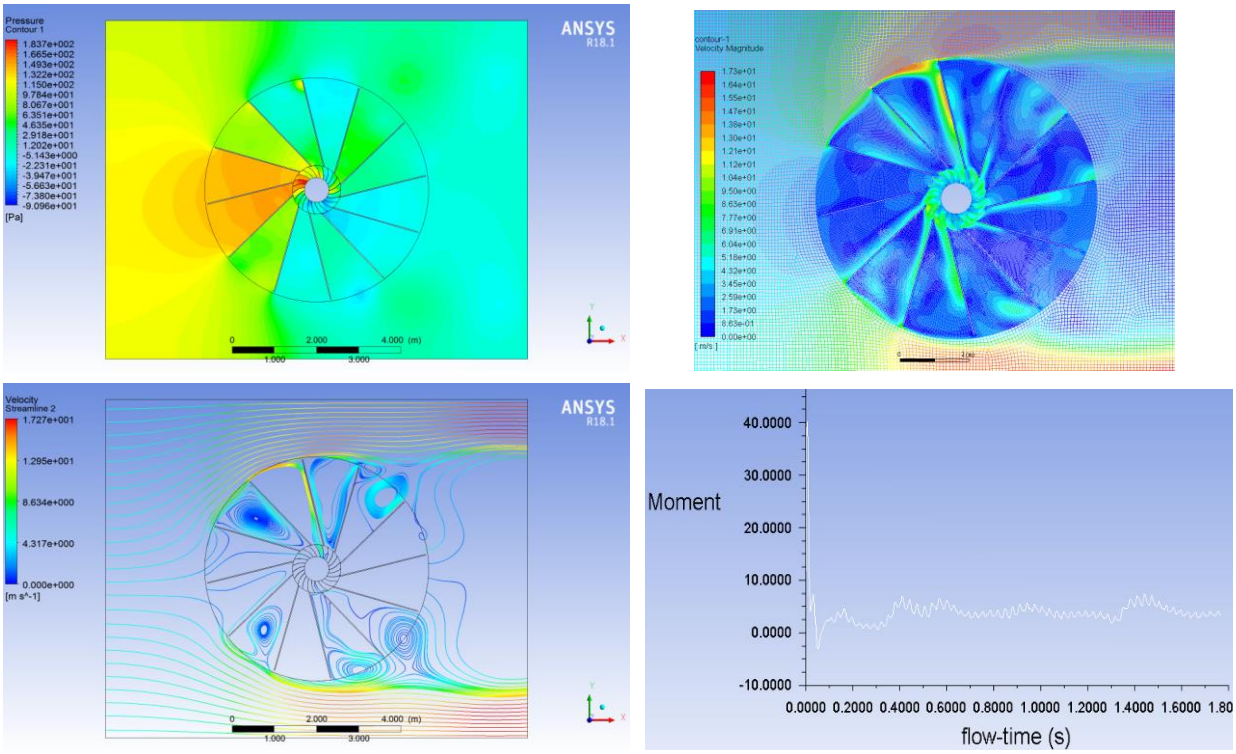
To about 6.2, besides the streamlines moving smoothly on the blades, so we think we almost reached the goal. You can see the attached video for this case. We moved forward and tested more configurations; the next configuration was 4 directors with closed center, see the figures [31-34]. We can realize that we have more vortices and the moment rescued to 3.17, as well as the velocity.





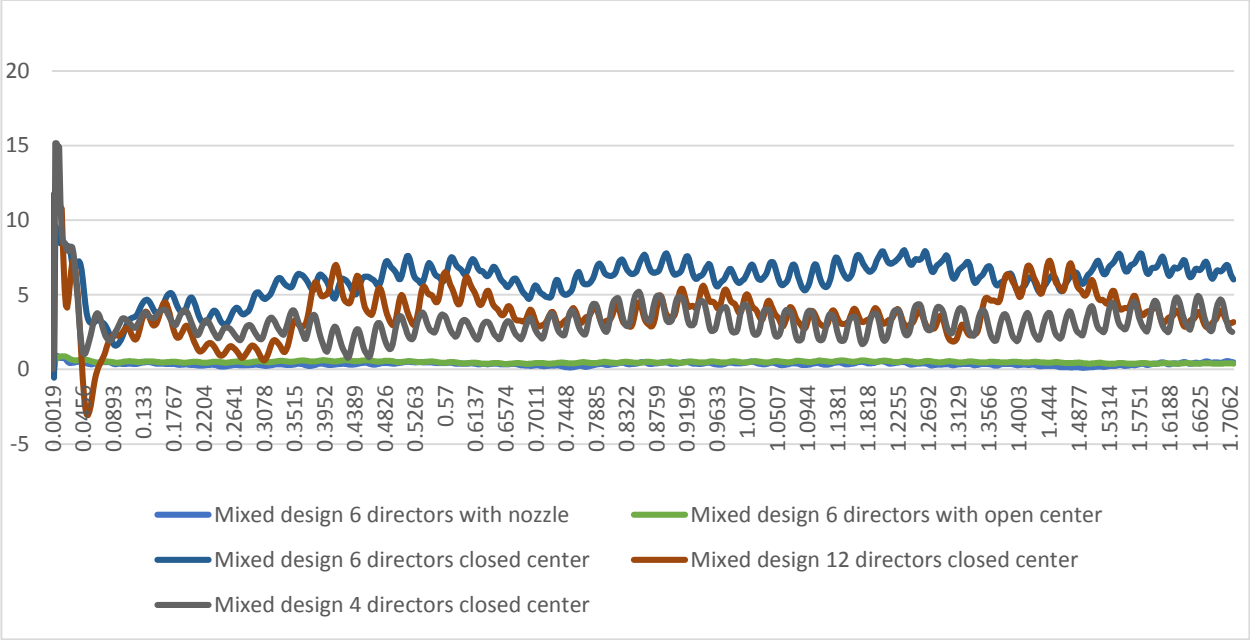
Figures [31-34] – Mixed design with 4 directors and closed center

The next configuration is 12 directors with closed center, see figures [35-38]. We can see that the pressure is 3.7, and it's lower than the 6 directors combination, but here we have less vortices and pressure.



Figures [35-38] – Mixed design with 12 directors and closed center

In the figure [39], you can see the comparison between the mixed design configurations. We can realize that the 6 director closed center is the best design.



Figures [39] – Comparison Cm for Mixed design configurations

4- The 30-degree base add.:

Suggested by you to add a configuration for the base so that it will have a tilt with 30-degree. We have studied the effect of addition this based and compared it with the case that does not have it. We have found that when the tilt based exist the velocity compression increases by factor of 1.61. See the figures [40-41]. The velocity has been measured at the end of the converged part of the directors.

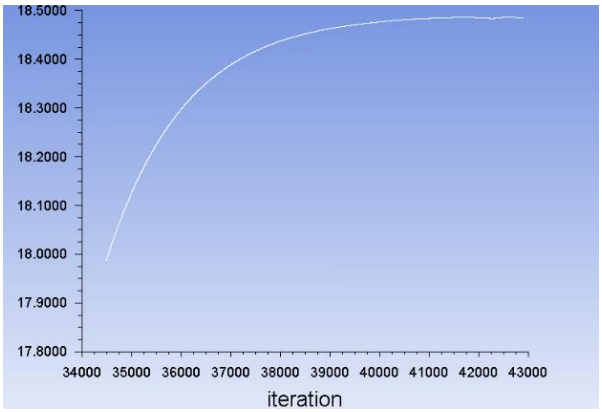


Figure [40] – with 30 degree base

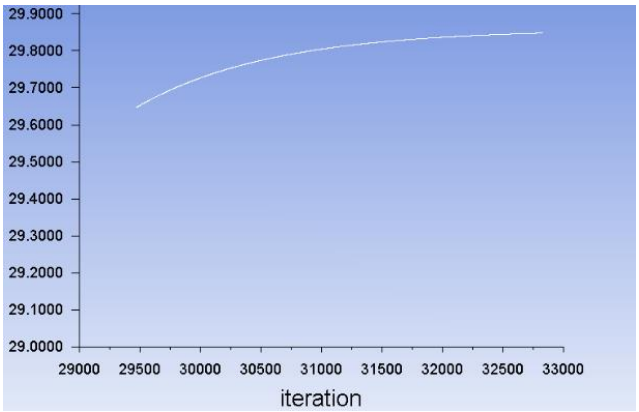


Figure [41] – w/o 30 degree base

This addition is flexible and we can add it to any configuration of the directors. Figure [42] shows the effect of adding 30-degree base on the Cm.

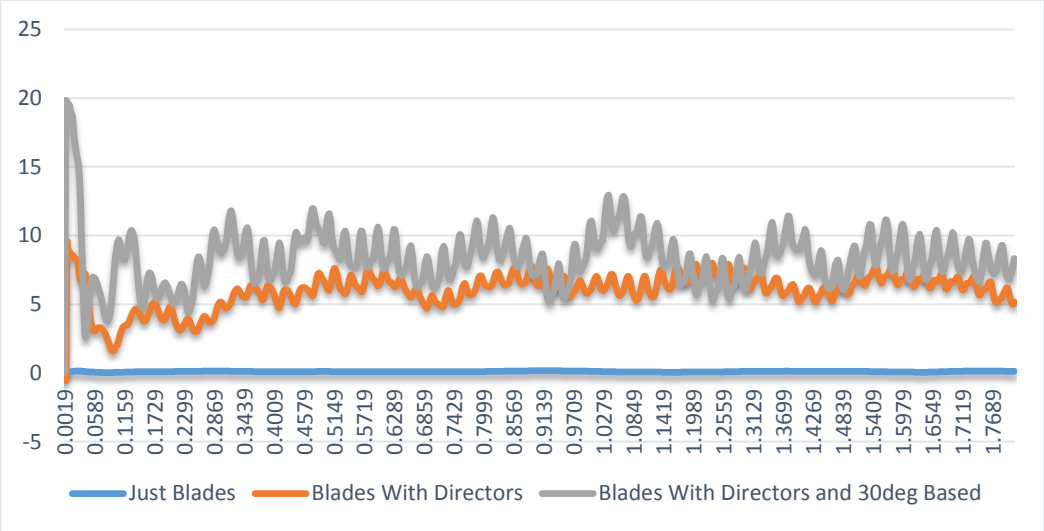


Figure [42] – The effect of adding 30-deg base

5- Results (Videos):

Video of the isolated turbine

FFF 14 13302.avi

Video of the turbine w/o 30-deg base

FFF 11 0940.1.wmv

Video of the turbine with 30-deg base

FFF 11 1400.dv

(Double-click to open the files)

6- Calculations:

The attached Excel file have the calculations of velocity and the Power. You can see them in the next table.

Wind Speed[m/s]	5
Diameter	1.14452
Hight	2
Cm Average	0.1029083
	6.22937
	8.2961755
L [N.m]	26.16540364
	1583.875941
	2109.380687
Velocity @ end Directors	5
	10
	15

Efficiency of Rotation	0.7
Angular Velocity	6.116101073
	12.23220215
	18.34830322
Efficiency	0.19
Power [KW]	0.030405748
	3.681115229
	7.353675727
Power [KWh]	0.021892139
	2.650402965
	5.294646523