CFD Analysis of Pump Sump

Our customer is an EPC contractor who is constructing Circulating Water System. The project involves construction of the sump by our customer and installation of the Vertical Turbine Pumps with guaranteed Hydraulic and Mechanical performance. DeMaas Tech Engineering Pvt Ltd. is engaged with the customer to perform CFD analysis of the Pump Sump in order to establish the optimum performance as well as ratify the correct pump operation sequence and philosophy.

CFD study were performed to evaluate the pump sump design at various water levels and to establish the sequence of the operation of the total 3 Pumps installed.

Simulations were performed at Low Water Level with various combinations of pumps operating as can be seen in the below table.

Table 1 : Various Pump Operation Combinations

Case No.	Pump ON / OFF Condition		
	Pump #1	Pump #2	Pump #3
1	ON	OFF	ON
2	OFF	ON	ON
3	ON	ON	OFF

⇒ The current Pump Sump configuration was analysed and Parameters like Value of Pressure Head, Liquid flow Pattern along with Swirl angle were evaluated.

⇒ A recirculation zone is observed at the sump slope just before the divider wall. Dead zone is observed in the vicinity of sump inlet.

⇒ A flow of water is aligned with the centre axis of pump.

⇒ Rotation of flow is observed near the vicinity of the bell mouth of the pump. However strainer and ribs near the pump bell mouth aids in aligning the flow with the pump axis and prevents the vortices from entering the bell mputh.

⇒ Maximum Swirl angle observed in the base design about 1.47° at Pump # 2 for case 2 and in rest of the cases in the rage of 0.68° to 1.2° which is less than the limited specified in HIS (5° maximum).

⇒ Considering the above No modification in the existing sump was proposed.

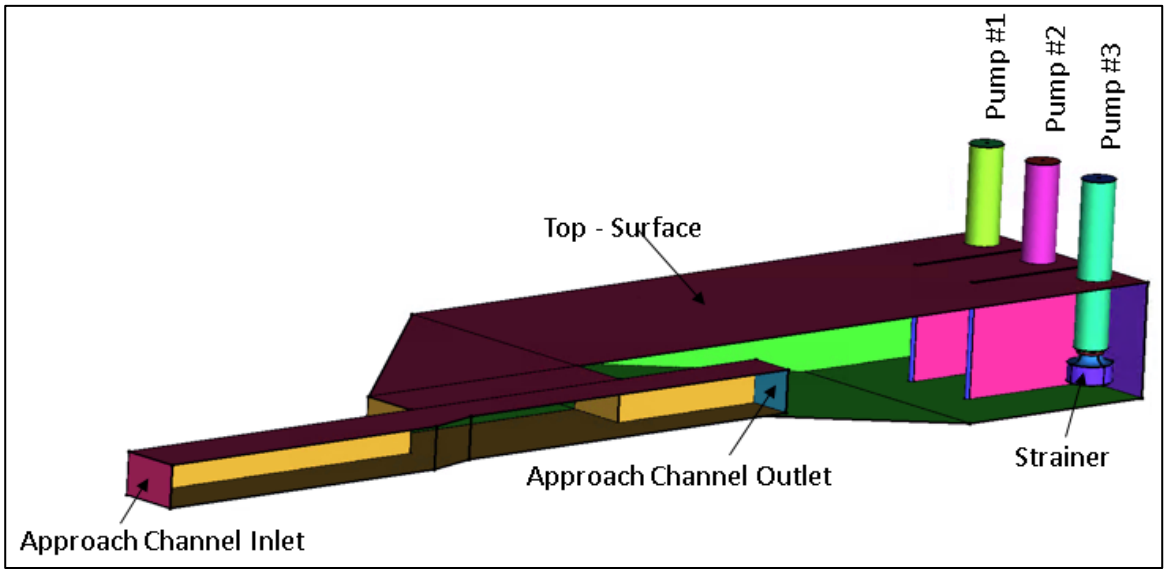

Figure 1: ISO View of Pump Chamber

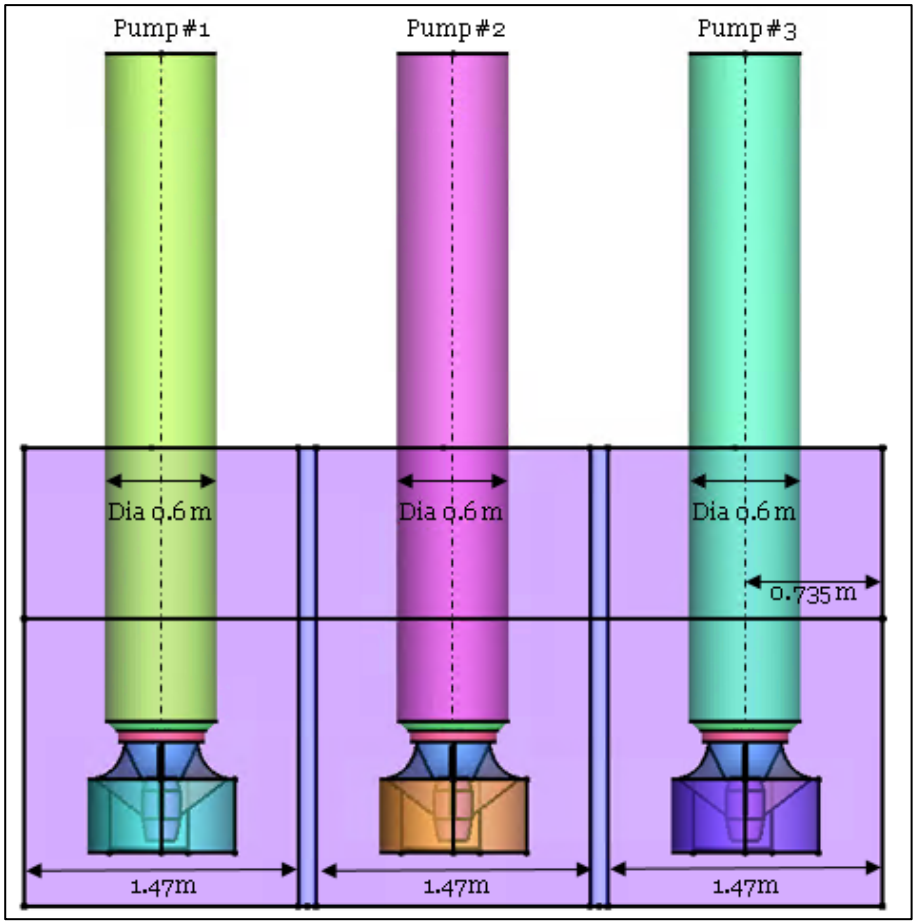

Figure 2: Front View of Pump Chamber

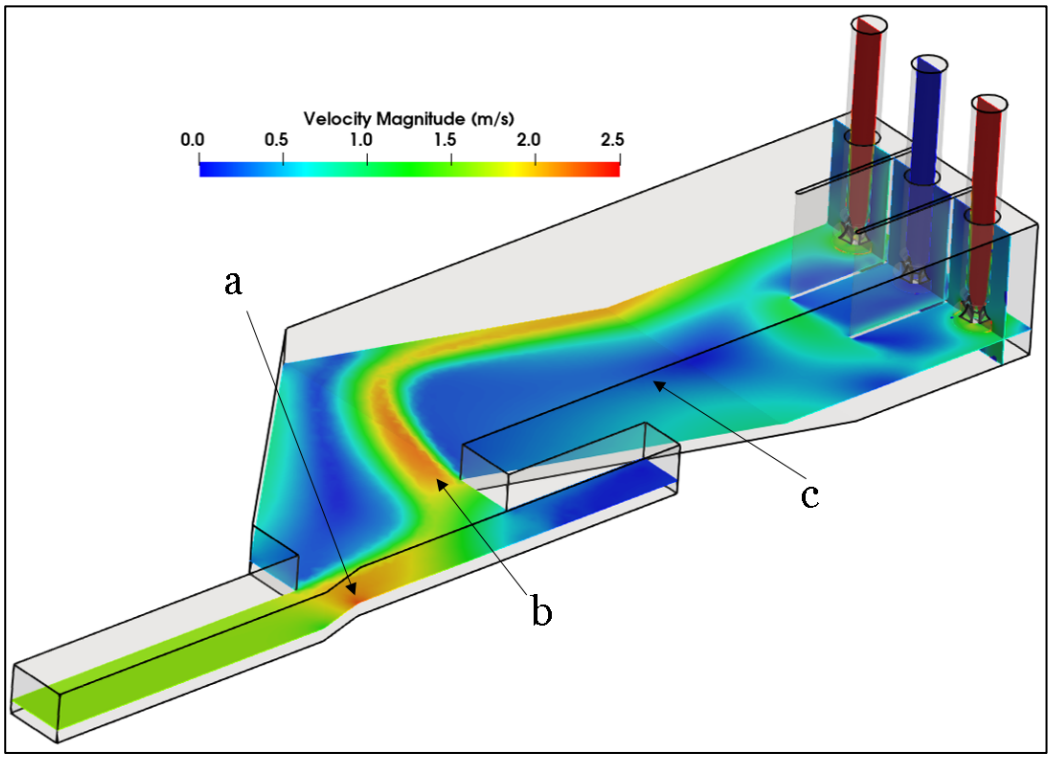

Figure 3 : Velocity Contour, Isometric – Cut Section View (Case 1)

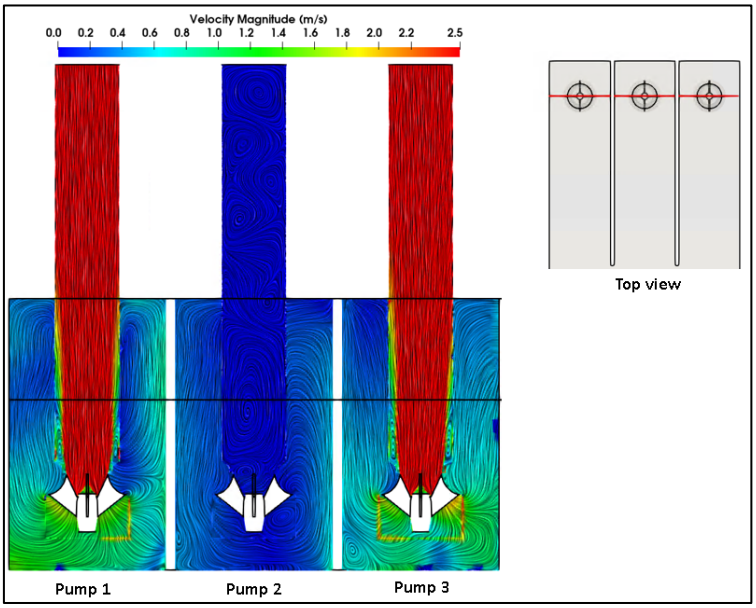

Figure 4 : Velocity Contour, Cut Section View at centres of different Pumps (Case 1)

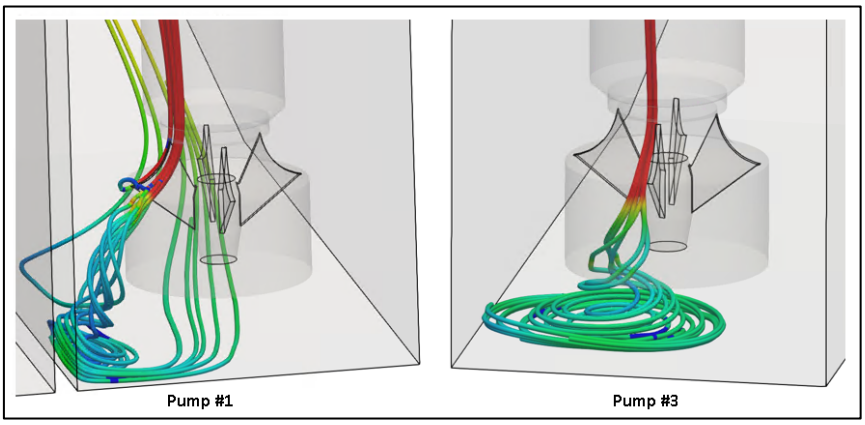

Figure5 : Velocity Streamlines at Pump Chamber #4 and #5 (Case 1)

Conclusion

Following conclusion points are made based on CFD results:

1. The Base Design was analysed and the existence of rotation of flow was observed near the Pump Bell-Mouth. However, the pump's strainer and ribs ensure that the flow is aligned with the pump axis, preventing vortices from entering the Pump Bell-mouth.
2. A recirculation zone is witnessed at the sump slope, just before the divider walls. Also, the dead zone in the vicinity of the sump inlet is observed. The formation of these zones are due to sudden change in flow direction from approach channel. **In spite of this, the average velocity at the inlet of each pump chamber ranges from 0.44 m/s to 0.49 m/s, which is below the HIS recommended value of 0.5 m/s, thus ensuring smooth and trouble-free operation of the pumps.** If the average inlet velocity were to exceed the HIS limit, the recirculation zone just before the pump chamber could potentially cause operational issues.
3. The analysis of pump performance in terms of Pressure Head for Sump operation reveals that the difference between the consecutive operating pumps are negligible. As a result, all pump combinations are viable for operation. However, case 1 is the preferred option.
4. The Swirl Angle values for different Pump Combination cases fall within the range of 0.68^0 to 1.47^0, which was less than 5° which is in the compliance with the recommended standard set by ANSI/HI 9.8 – 1998.
5. **The existing sump is suitable for the Operation of all Pump Combinations and therefore No Modifications are required in the sump.**

Details on DeMaas Tech capabilities & specific Engineering study requirements can be discussed in details with interested customers.