CHAPTER V
CLOSING

5.1 Conclusion

Based on the simulation results of mass concrete with internal cooling pipes under varying Reynolds numbers, it can be concluded that while the temperature distribution remains relatively uniform near the inlet, significant differences appear further along the pipe. Higher Reynolds number flows are able to sustain effective convective heat transfer over longer distances, resulting in lower overall temperatures and more persistent radial gradients in the concrete. These sharper gradients contribute to increased thermal stresses in the downstream regions. The enhanced cooling performance of high Reynolds number flows is due to the transition from laminar to turbulent flow, where turbulent conditions promote chaotic motion and continuous mixing of fluid layers. This disrupts the thermal boundary layer and allows cooler fluid to reach the pipe wall more effectively, improving heat extraction. In contrast, laminar flow at lower Reynolds numbers limits heat transfer due to minimal mixing and a thicker boundary layer. Therefore, maintaining a sufficiently high Reynolds number is essential not only for effective cooling but also for controlling thermal stress, reducing the risk of cracking, and ensuring the long-term durability of mass concrete structures.

5.2 Recommendation

For future work, it is recommended to expand the simulation by incorporating structural restraints into the analysis. Since massive concrete elements are often partially or fully restrained by surrounding soil, formwork, or structural supports, their thermal expansion may be limited, leading to significant tensile stress and increased risk of cracking. A coupled thermo-mechanical model that accounts for both transient heat transfer and stress evolution under restrained conditions would allow for a more realistic assessment of crack development.