# THERM_VENATION: Active Thermal Façade Venation

**Fabricating a concrete twin-wall façade panel optimised for integrated heat exchange system**

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## Reflection

This thesis was driven by the studies and trends that the current trends of architecture in India do portray upon my understanding of a sustainable approach in Architecture. The project was based and referred through various different research projects within the faculty and around the world. At the initial phase, while the motivation of the project had an inclination, the goal was not clear enough to be driven for a robust research. The initial approach did not work enough because of the lack of clear problem identification and the numerous amounts of solution that made it complex to be evaluated. With further investigations, understanding of the chosen topic, discussions with my professors and their feedback, the topic was narrowed down to focus upon a specific goal within the bounded limit of the time phase. The active participation of my mentors coupled up with their expertise and vision did drive my final project to be specific and precise with a value of scientific evaluation and application.

**Research approach for the thesis and workout.**

This thesis deals with the optimisation of fluid flow networks and fabrication of a facade panel with complex geometries. This project being based on the design by research approach, has been constantly weighted and evolved from numerous iterations within this time frame. The initial lack of knowledge about the specifics of physics and simulation software were a hurdle. The lack of being in contact with guidance specifically related to the fluid flows within the faculty gave me a run to look for assistance from the faculties

of Civil and 3ME. It is well understood and accepted that the one aspect of the topic explored in this research is not in direct relevance to that of Architecture. To the rescue my mentors did assist me in contact with a researcher from the Nottingham University who is currently pursuing his research in the topic that did concern me. This was of great help to verify the scientific relevance of my research as well as to ensure my proper guidance to reach the final goal as envisaged by my vision.

**Challenges and hurdles faced during the conduct of the thesis.**

During the conduct of the research and study, there were certain technological challenges that had to be compromised at instances. For example, the lack of full license for specific simulation software like Ansys did limit the accuracy and validation of the simulations. While this project deals with highly complex curved geometries, the restriction on the maximum number of nodes for CFD as well as structural simulations did affect the levels of errors or inaccuracies of the results. Also, the lack of testing sample of materials needed was a big drawback. Tests at early phase using the desired materials with a fixed variable would have stretched the boundaries, possibilities and efficiency of the design. The lack of these resources led to compromise at certain sectors and the design was modified to adapt to the available resources and their limitations to be dealt with. To be agreed upon, these limitation and constraints by resource availability also did cater in expanding my ideas and made me tackle such situations with smart and alternative idea and which I have cherished and accomplished with this project.

**Position of the topic of the thesis in the graduation studio of building technology track.**

My experience while pursuing the building technology track of Architecture in the faculty did deal with specializing in computation, facade and fabrication of building elements. The quest of exploring the combination of my specializations in the thesis did lead me to explore this topic, since this project deals with fabrication of a segment of facade panel with a complex network of heat exchange tubes within at 1:1 scale of prototype. From designing the geometry by making use of advanced computation tools to that of fabricating the panel, dealing real world challenges, industry standards and skill to explore new possibilities and challenges, did enhance my abilities and knowledge to a greater extent. Above all these criteria the responsibility to derive the sustainable aspect of the project was also prioritised.

**Contribution of the proposed design towards sustainable development and societal impact.**

The extent of research done to derive the comparative analysis of the material used in the project to that of potential other materials is an evident of a sustainable approach this thesis. Suggesting alternative energy-efficient measures and recyclable materials in the production methods is another. The use of passive measure to conduct heat exchange with the most energy potential building element of a structure- the facade, the aspect of sustainable development dwells upon. This ideology is also stretched to be extended further with efficient use of materials by minimising the volume of material consumed while simultaneously increasing the efficiency of the system.

The alarming rise of energy crisis and mandatory implication of sustainable measures in today's architecture has led to development of passive measures that can be coupled up with the present technology for higher efficiency. The most primary element of energy harvesting in a structure is from that of a facade, which is crippled with limited measures of passive alternatives that can be used on a facade without compromising the aesthetics. The system proposed in this project, lets the user define its architecture in a traditional manner while incorporating such passive measure of complex heat exchange systems within.

**Research Methodology followed by me in the conduct of thesis.**

The track of building technology dives deep into the technical aspects of the built environment while being in consideration to the terms of architecture. This project is placed exactly at the juncture of these two disciplines, outlining the current state of demand in design in aspect of the façade and combining it with the state-of-art tools of optimization and modern fabrication techniques.

With an extensive study and analysis through literature, the research of this project is partly based on principles and systems researched before in different disciplines and combined together with new findings, experiments, design integration and adaptations to the different criteria associated. It deems to be further developed and researched for multiple building elements. The proposed system is a preface to possibilities of fabricating complex geometries within concrete and holds true to be extended its application for heat and water distribution systems in slabs and facades. The finding and conclusion of this project adds a bead to a thread of researches in the segment of fabricating efficient heat exchange systems and water distribution channels.

**Moral and ethical issues in concern with the proposal of the thesis.**

The project also deals in some dilemmas with the ethics of its conduct. This extends from the materials used to that of assumptions made and the errors due to the constraints of available technology. The material concrete with its high potential which largely uses natural materials in its composition is held responsible against sustainability for the high embodied energy of cement used in it along with the steel. While measures against steel have been addressed to a greater extent in this project, the consideration of rapid development in the segment of materials to replace cement responsibly in the future has been considered and kept out of the scope of this project. While the afterlife of the materials in this project are considered and referred to be that of a sustainable measure, the practical viability of the same in the contexts proposed may vary largely. Also, the factor of added cost in the manufacturing of complex geometries and high-efficient materials to that of the current traditional practices has been kept off the scope of this project and its research.