Graduation Topic:	Urban facades: Photocatalytic Building Envelope for Passive Remediation of Air Pollution
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REFLECTION:

Building facades have evolved over time from being structural systems to transparent light weight systems. Recently, they have taken over the function as energy producing surfaces for buildings self-sustenance. The goal of satisfying the building needs should be broadened to consider the urban benefits as well. This has led way to adoption of photocatalytic building materials which is the focus in the thesis.

Graduation Process:

Step 1: Understanding the material science

The focus of this project being photocatalytic building materials, the initial stage of this project was focused on material science to understand the chemistry and favorable working conditions of the photocatalyst and their application methods on building materials. Most of the studies focused its application on pavements and roads which are the immediate receptors of the emission from the exhaust system. Case studies of application of photocatalytic materials in various tunnels and street canyons proved the air purification effect in the vicinity of the surface. At the same time, they helped in relating to the laboratory test conditions like flow rate and irradiation levels for these materials to an urban scenario.

Although, photocatalytic building materials has high scope in terms of its material science, the literature studies about their performance requirements helped in framing the research question oriented to a design of façade product and its evaluation.

Step 2: Understanding the context

Studying the pollutants and their dispersion mechanism in urban situations for different climatic conditions proved the potential of facades to integrate such building materials into their envelope for pollution abatement. A reference context (Putney high Street, London) with high NOx pollution was picked to use the weather and pollutant data for further analysis and design.

Environmental factors like wind and irradiation influence the performance of these materials. Hence, design situations to perform wind analysis and irradiation analysis were framed.

Step 3: Design phase

Design strategies for surface enlargement and roughness elements were experimented and parameters were framed and applied to derive a conceptual design. The strategies for design were individually framed for each requirement and combined onto the concept and tested for results. Various concepts were compared for the UV irradiance levels and optimum solution out of them was developed with appropriate materialization and fixing methods. Form finding the optimized façade panel for irradiation and lesser incident velocity in one multi-objective step was the initial goal. However, combining the identified tool on one work interface was a did not work as planned. Hence, a stepped strategy was adopted to frame the concept.

Result phase:

Evaluation of the façade system designed is analyzed for limited variables and does not accommodate the changing weather conditions of the site. Also, the intermediate appearance and disappearance of other byproducts were neglected. Hence, this reduces the accuracy of the result. Air-purification effect of the active flat-façade and designed geometry was analyzed for a standard climate scenario in London that proves its potential improve the quality of air up to 13% on a standard summer day. However, the extent of purification cannot be generalized unless it is analyzed for more situations on a time dependent model.

Societal Relevance:

Clean air and good health are basic human necessities for good functioning. Inhaling harmful and toxic air affects the respiratory, heart and brain health of humans irrespective of the age which leads to early deaths and complications. Hence, more active and passive strategies need to be integrated at various levels for air quality improvement. Photocatalytic building materials consume the pollutants and break them down into safe byproducts like nitrates. The resultant improvement in the air quality improves the health of the population and quality of the surrounding environment.

Environmental Relevance:

The emissions in the environment worsens the air quality by leading to secondary reactions in the presence of light. Photochemical smog is a phenomenon that occurs when these pollutants react with UV in sunlight. Application of photocatalytic materials can help in reduction of frequency of these situations in warm and sunny region. To a certain extent, they help in abatement of pollution. But, the effect of the nanoparticles if TiO_2 washed into soil could be toxic to living organisms. Life cycle assessment of the photocatalytic facade in future would help in understanding its sustainability.

Scientific Relevance:

Application of photocatalytic building materials have been tested on pavements, acoustics barriers and building facades as a coating. However, very few case studies talk about the improvement in surrounding air quality. Also, the effect of geometry in the pollution abatement performance is a part which has not been researched upon. This information lag that bridges design, application and effectiveness make it difficult for the investors to understand the benefit of applying such technology at an urban level. This thesis may not be the conclusion, but a starting point to understand and bridge this information gap between design of photocatalytic panels and effectiveness of the material for the applied purpose.

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