Building-Scale Solutions for Urban Growth and Increasing Energy Usage in Hot-Humid Climates

by

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A Thesis Submitted to the Graduate
Faculty of Rensselaer Polytechnic Institute
in Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE
Major Subject: ARCHITECTURAL SCIENCES

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Rensselaer Polytechnic Institute
Troy, New York
November 2012
(For Graduation December 2012)

ABSTRACT

Due to rapid urbanization and population growth, Bangladesh is struggling to balance increasing energy loads with decreasing space and resources. These issues are compounded by frequent flooding, natural disasters, and shortages in energy and potable water. Concurrently, globalized architecture, concrete construction, and energy intensive mechanical systems are rapidly replacing vernacular housing typologies, ignoring climate-based strategies and worsening the aforementioned issues.

This housing crisis accounts for the bulk of the energy use in Bangladesh, as the residential sector currently accounts for nearly 46% of Dhaka's total energy consumption. Relief initiatives and innovative proposals for water shortage, energy generation, and residential density are copious, but reactive, and only tackle one issue at a time, not taking advantage of environmental flows at multiple material and temporal scales.

These issues are not limited to Dhaka, or even Bangladesh, but are global issues urgently in need of attention – particularly in tropical developing urban areas. If material and ventilation strategies used in vernacular and informal housing typologies are recognized as assets for low-energy and climate-responsive design, then these principles can be applied to formal proposals for hot-humid climates to provide for the projected population growth and reduce energy loads.

In these hot humid climates, one of the main challenges facing energy reduction with respect to thermal comfort is finding a viable means of passive dehumidification. This thesis will pair mechanically-assisted passive flow control strategies with coconut husk, an agricultural by-product and natural desiccant, to create a residential solution that improves thermal comfort, reduces energy needs, and provides a socio-economic framework. This will be done by re-thinking the way that mechanical ventilation systems interact and deal with humidity, air flow, and the structure and design of housing units. Bioclimatic information, TMY3 weather data, desiccant properties, material and construction costs, and seasonal shifts will be considered in a data-intensive way through energy modeling, load calculations, and design iterations which respond to those results.

This approach is significant because it is projective rather than reactive and can re-couple culture and nature through climate-based design. The findings show that by combining these strategies, there can be potential benefits beyond energy reduction – yielding possibilities for economic growth in the agricultural sector, reductions in building material imports, and increased quality of life at a lower cost of living. Further experimentation could consider global impacts of the proposal and investigate needed modifications in size, scale, material, and deployment for other locations and climates.