Prioritizing Resilient Retrofits

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PROBLEM

2017 was one of the most devastating U.S. hurricane seasons ever recorded. State Departments of Public Safety across the country list tens of thousands of destroyed homes and hundreds of thousands more damaged. Although the total economic impact is still being measured, estimates from NOAA's National Centers for Environmental Information place damage costs for weather and climate related disaster events at over $300B, with hurricane-related costs accounting for more than $200B of that total. While it's true that rebuilding infrastructure to be more resilient will reduce the risk of future damage, it is not feasible to rebuild entire cities. It is possible, however, to identify the specific buildings in cities that are most vulnerable to failure as a result of intensified wind loads and to make those buildings much more resistant to hurricane damage through already well-known hurricane-proof retrofitting techniques. In this brief we examine how additional long-range city texture parameters can be used to create urban models that enhance our previously established computational fluid dynamics (CFD) methods.

APPROACH

During initial research and modeling, when testing CFD samples of 196 buildings we found that buildings exhibit geometrical variations that extend beyond the distance of our original measure of eight local neighbors (fig.1). To quantify those differences, it was necessary to adopt an approach that captures long-range geometrical characteristics. We accomplished this by using length parameters that have traditionally been used in molecular physics to quantify properties of materials, namely: chord, contour and persistence lengths. In the context of buildings and cities, these parameters act as urban canyon measures at the block scale as opposed to the neighboring building scale.

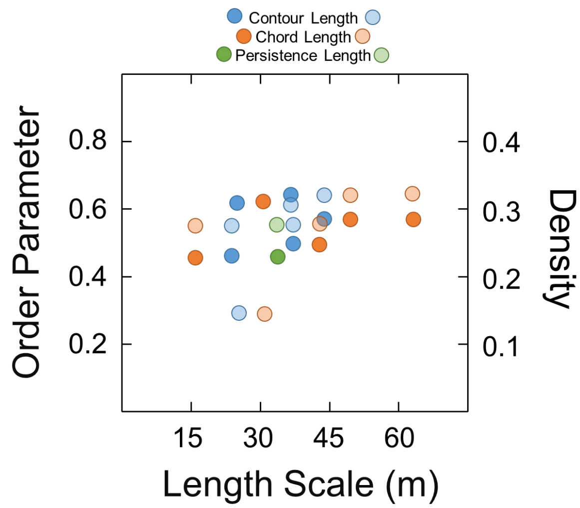

Fig.1: The relationship between local city texture parameters and long-range length scales show no apparent correlation, which proves that building samples exhibit geometrical patterns that extend beyond the set of local neighboring buildings.

FINDINGS

By incorporating length scale parameters into the analysis of cities, we have refined our approach of generating CFD samples that resemble cities at both local (i.e. neighboring buildings) and long-range scales (i.e. block scale). By measuring wind loads in CFD simulation for the generated models, we are able to obtain a set of variables for each building that defines its unique vulnerability to failure. Our next research step will entail more CFD simulations using actual GIS city data followed by validation using damage data from the impacts of Hurricane Harvey for the city of Houston, TX.

WHY DOES THIS RESEARCH MATTER?

- The approach proposed in this brief provides a way of quantifying a set of variables that define a specific building's vulnerability to wind damage.
- For each building in a city, researchers can calculate parameters and translate them to resilient retrofit maps.
- This method allows efficient identification of buildings that would most benefit from hurricane-proof retrofits.

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