Combating Storm Surge Inundation in Underground Transit Systems

Mitra, Kyle
Janis, Raymond

During Hurricane/Superstorm Sandy, many areas throughout New York City experienced flooding due to storm surge. The Metropolitan Transit Authority's failed efforts to preserve the subway infrastructure led to high levels of internal flooding due to extensive water flow through subway ventilation gratings. In this investigation, we have redesigned the standard ventilation grating, presently used in New York City, to reduce storm surge inundation. Computer-Aided Design (CAD) drawings of brainstormed designs were prepared, and they were analyzed using Computational Fluid Dynamics (CFD) software. Viable solutions were compared to the modern-day gratings through storm surge replication tests, ventilation simulations, and stress and deformation analyses. The most promising solutions were physically assembled as small-scale PLA plastic models using 3D printing to test functionality. The most effective design implements an inverted lateral system, which can be manually closed to seal subway gratings before an anticipated storm surge. Data analysis of this system indicated its ability to eliminate nearly all storm surge inundation, maintain higher stress tolerance, undergo less deformation over time, and retain similar ventilation properties to the current grating. The newly redesigned grating is able to eliminate nearly all damage and storm costs associated with storm surge inundation while retaining the ability to function as a proper ventilation grating. The redesigned grating requires a one-time installation in storm surge susceptible regions of New York City and would recover all initial costs after a single storm.