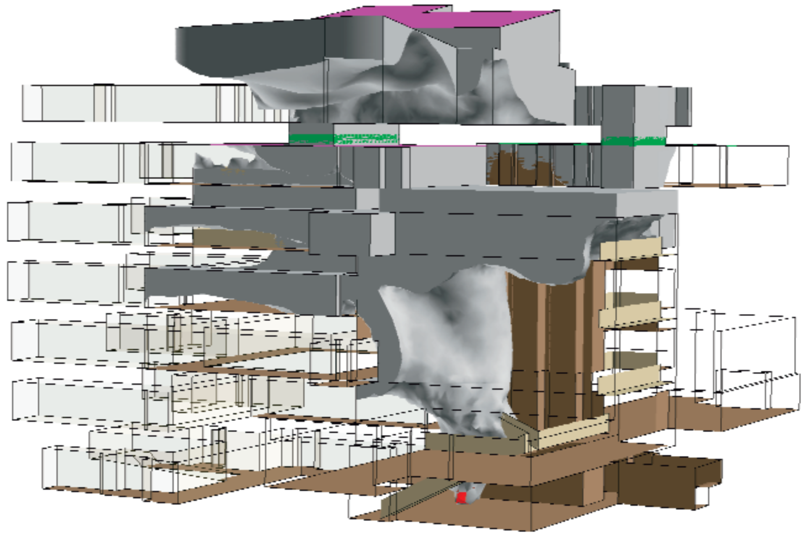

Smoke, represented by a gray iso-surface, penetrates into many occupied areas of a building with a complex atrium

Containing Smoke in Complex Atria

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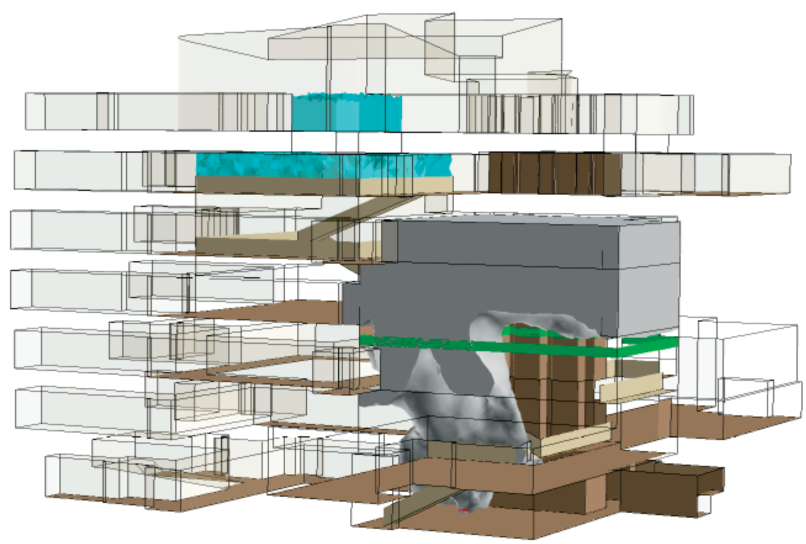
Atrium spaces are a popular means of creating a sense of openness and comfort for building occupants. The architecture of these spaces is becoming increasingly complicated as designers work to balance energy efficiency, aesthetics, and visual impact. One of the challenges in designing such spaces, however, is engineering a smoke management system that can maintain tenable conditions in the space so that there is sufficient time for the occupants to escape in the event of a fire. The difficulties are a result of the interactions between the smoke, the architecture, and the airflows. These interactions lead to disturbances in the rising smoke plume, which in turn cause excess mixing of the smoke with clean air, resulting in a larger volume of smoke to be exhausted. For example, overlapping levels or bridges across open spaces can lead to multiple balcony spill plumes, and architectural features can narrow the available flow area and cause local flow accelerations.

At RWDI, an internationally recognized engineering firm, FLUENT has been used to better understand the workings of complex atria in the presence of a fire. In one recent study, an atrium was studied that consisted of multiple levels and connected spaces. The space was outfitted with a smoke management system developed by following the local code, and the CFD results showed that with this system in place, smoke would penetrate into many of the occupied areas of the building.

In RWDI's experience, providing a code specified quantity of exhaust at the top of the atrium is not always sufficient for a safe atrium design. Other design strategies are necessary to help keep smoke out of the occupied zones, and RWDI uses a number of these to improve smoke management systems. For example, an atrium can be segregated into smaller and simpler atria when a fire erupts. Segregation in this particular atrium led to measurable reductions in undesired smoke propagation, used less than half the exhaust air, and saved the owner both capital and operating costs.

Proper use of CFD models for the design of smoke management systems also requires an understanding of smoke plume dynamics (including ceiling jets and thermal stratification), sprinklers, tenability (including visibility, toxicity, and thermal exposure) and external wind effects. To ensure that the correct quantities of smoke are being produced, it is important to use properly calibrated CFD methodologies. Otherwise, underprediction of smoke transport may lead to an inaccurate assessment of the required exhaust rate. In addition, the smoke generated by a fire in an enclosed space should not be simulated using the same methods that are suitable for a large open space. The proper use of CFD modeling to assess smoke transport has allowed RWDI to demonstrate successful ventilation designs, leading to safer, cost effective smoke management systems. ■



The same fire scenario as above, but with a smoke management system that segregates the atrium