RESEARCH NEWS

Protecting buildings from flooding events

Simulation Software Boosts Climate Resilience in Buildings

Storms, hail, rising floodwaters — extreme weather events have caused billions of euros in damage in recent years. In the ResCentric project, researchers from the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI have developed a simulation software that can identify risks associated with construction infrastructure, calculate the likelihood and costs of damage and pinpoint measures to protect property against climate-related risks. The focus is on the resilience of buildings.

The catastrophic flooding that struck Germany's Ahr river valley in 2021 and a wide swath of southern Germany in June of this year offered vivid proof of just how vulnerable our infrastructure is. According to the German Insurance Association (GDV), insurance claims involving damage to homes, household effects, and businesses are rising by millions of euros a year. Preventive construction measures and adaptations to address the effects of climate change are becoming indispensable as extreme weather events increase in frequency and severity. In the ResCentric project, Fraunhofer EMI has teamed up with an industry partner to develop a software program to assess the effects of extreme weather. The simulation software evaluates the damage and downtime affecting several-story administration and office buildings, industrial facilities or single-family homes, with a special focus on flooding caused by extreme precipitation and on high wind scenarios. Plans call for future versions to account for heat waves and forest fires as well.

"Extreme precipitation is extra dangerous because it comes without warning. It occurs more and more frequently and often does tremendous damage. Our overarching goal is to strengthen the resilience of urban structures," says Dr. Julia Rosin, a scientist at Fraunhofer EMI in Efringen-Kirchen, near Freiburg. She and her team are developing the platform, which can be used to assess the monetary impacts of climate-related extreme weather events and identify strategies to reduce the damage, setting the costs of taking action in comparison to the financial losses and factoring in the likelihood and intensity of climate extremes along with the associated risks. "The software lets us calculate for specific buildings what the costs of damage due to climate phenomena will be and how much repairs will cost. One thing that makes our software special is that we can associate the costs with specific root causes. We can also analyze the loss of income when a property is out of commission, whether due to lost rent or production downtime, so we can see at what point measures to improve those properties start to

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pay off," Rosin explains. These calculations benefit real estate investors, insurance companies, reinsurers, and housing companies and associations, along with administrative agencies. In addition to the damage itself, the software can also be used to identify failure patterns, quantify the likelihood of various types of damage, and qualify improvement measures and assess their efficiency. From doors and windows to light wells and the entrances to underground parking garages, everything needs to be scrutinized. "Modern triple-sealed doors can keep water from getting in. Replacing windows with triple-pane versions can also help to prevent water damage. Our software supplies a whole catalog of preventive measures, including their respective costs."

Put to the test: calculating damage to buildings

Real estate companies can import their property holdings or portfolio into the software, which then calculates the appropriate damage forecast for a particular building and weather event in seconds. This is done partly by using generic building models, a central element of the software. These simplified mathematical models account for typical building features with regard to structure, materials, and style of construction. Representing a broad range of building types, the models can be used to assess how vulnerable a large number of buildings are to flooding. Probabilistic analyses of generic building models are based on the use of probability distributions for different parameters, such as the depth of floodwaters, how fast the water is flowing, wind intensity, hailstone size, objects that are flying around, and the strength properties of the construction materials used. Combining these probability distributions allows Rosin and her team to make statistical inferences about the likelihood of expected damage. "You could think of it as us running calculations for a typical building and then translating the results to all buildings that are similar to the typical one," she explains. The team currently has building models for multi-story administration and office buildings, industrial facilities and single-family homes, with plans to add further property types to their portfolio in stages. There are also plans to create interfaces to link the software with digital city models. Once those interfaces are in place, municipalities could respond to the requirements of climate change at the urban planning level and take the necessary precautions.

Fig. 1 Vulnerable infrastructure: The disastrous flooding when the Ahr river burst its banks showed how vulnerable our infrastructure is.

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