To The Point
Extreme Heat and the Built Environment

When outdoor temperatures rise to the extreme, our built environment is at risk. Common construction materials such as metal, asphalt, or concrete expand when they are heated. When repeated expansion and contraction occur during a prolonged or extreme heatwave, these materials can crack, warp, or experience structural failure. In addition, extreme temperatures can accelerate the deterioration of certain materials, leading to more frequent replacements and increased capital expenditures. Strategies exist for building owners and operators, businesses, and communities to adapt to rising temperatures, protecting both people and property from the worst impacts of extreme heat.

By The Numbers

Urban areas are on average 10°F warmer than their surroundings, a phenomenon known as the "urban heat island effect"[1] – meaning that dense physical environments of buildings, roadways, rail lines, and energy systems are particularly at risk. When high heat is paired with high humidity, the impacts can be multiplied.

The consequences of extreme heat can be severe and disruptive to communities and businesses. A historic 2021 heat event in the U.S. Pacific Northwest caused cables powering Portland, Oregon's light rail system to melt, suspending transit service in the city.[2] In 2022, record-breaking temperatures in the U.K. caused London's Luton Airport to suspend flights due to a buckled runway, while regional rail systems cancelled or reduced trains due to similar risks on their rails.[3] It is estimated that costs for U.S. Road maintenance due to high temperatures could reach $26 Billion by 2040.[4]

Building Design

Every building has an "envelope" made of up of the physical components which separate the interior of the building from the exterior world. The building envelope, which includes walls, roofs, foundations, windows and doors, is a critical part of how temperature is managed in a building – and consequently, also effects how much energy must be expended by a building's Heating, Ventilation, and Air Conditioning (HVAC) system in order to maintain indoor temperature.

Building owners, developers, and architects can consider strategies to strengthen a building envelope's ability to manage extreme heat, including:

- **Roofing:** Direct heat from the sun, known as solar radiation, enters a building through its exterior materials like roofs and walls. Cool roofs are made of materials or coatings that lower the temperature of the roof itself and decrease the heat transferred to the building.[5] Cool roofs come in a variety of types suited for different roof slopes, locations, or application strategies. Examples include white or light-colored liquid applied roof coatings; shingles or tiles made of light colors or naturally cool materials like terra cotta; or directionally reflective materials.[6] Green roofs, which cover the roof with vegetation, also help keep the roof cooler and reduce heat transfer into the building.[7]
- **Exterior Paint:** Similarly, bright and light-colored cooling paints are designed to decrease heat transfer through a building wall.
- **Insulation & Sealing:** Regardless of direct solar radiation, hot outdoor temperatures can affect a building both from heat transfer across walls, roofs, and windows and by hot air entering through cracks and gaps in doors, windows, and other openings. Choosing or upgrading to more efficient insulation materials and well-sealed doors and windows is a key strategy to reducing indoor temperatures.[8]
- **Passive Cooling:** In addition to materials and insulation, so-called passive cooling techniques use a building's siting and design elements to prevent direct sunlight from entering and heating a building. This may include strategic placement of windows to reduce direct sunlight, incorporating trees and shrubs to shade a structure, and encouraging airflow through interior spaces to cool a building without air-conditioning.

Building design that reduces heat transfer offers many co-benefits for building occupants. As less heat enters a building, energy needs and costs are lowered. When applied at scale across a community or city, these strategies can reduce the urban heat island effect and improve related public health outcomes.

Some cities and municipalities have adopted building codes which support extreme heat adaptation, such as standards in Atlanta, Georgia and New York City which require new and renovated rooftops to meet certain solar reflectance standards.[9] The California Air Resources Board found that a cool roof can provide 30% or higher energy savings during peak demand. [10]

Infrastructure & Transportation

In high temperatures, key pieces of infrastructure are impacted as materials like asphalt roads and metal tracks are under stress. In addition, air travel can be impacted through stress on physical runways as well as reducing the ability of airplanes to generate lift.

These consequences affect not only the builders, owners, and operators of transportation networks – but can cause severe interruptions for businesses and daily users who rely on them for commerce.

Key considerations for transit infrastructure include:

- **Material Innovation:** Traditional materials for roads, sidewalks, and other infrastructure can be vulnerable to cracking and warping in extreme heat. For roads and sidewalk surfaces, "cool pavements" are those made of materials that have increased solar reflectance or are made of permeable materials. These pavements can reduce the heat island effect while offering co-benefits such as better water permeability and better nighttime visibility. [11]
- **Business Continuity Planning:** Businesses can develop a Business Continuity Plan to identify and document how they will continue to deliver critical products or services in the face of disruption, including assessing how supply chain and transportation network disruptions would interrupt business as usual.
- **Operational Planning and Monitoring:** Proactive monitoring and maintenance are essential for keeping infrastructure safe and functional during extreme heat events. Real-time sensors embedded in roads, rails, and bridges can detect early signs of heat-related stress, such as expansion or cracking, allowing for timely repairs before failures occur. In addition, transit agencies can implement heat action plans that include speed restrictions, schedule adjustments, or temporary rerouting to maintain service and protect public safety.

Energy and Cooling

Investment in resilient energy and cooling infrastructure mitigates operational risks associated with extreme temperatures:

- **Efficient Building Cooling:** Upgrading to high-efficiency cooling systems can allow building owners and businesses to better withstand extreme heat while reducing operational energy costs. Modern HVAC systems with variable speed drives, smart thermostats, and advanced filtration can deliver cooling only where and when it's needed, significantly reducing energy consumption and operating costs. According to the U.S. Department of Energy, high-efficiency air conditioning units can use up to 40% less energy than conventional models, providing both immediate and long-term savings.[12]
- **Cooling Technologies for Critical Assets:** Protecting critical assets from overheating is essential for maintaining reliable service. Advanced cooling systems for data centers, substations, manufacturing sites, and other heat-sensitive facilities can prevent equipment failures and costly downtime.
- **Grid Hardening:** As temperatures rise, energy systems face increased demand and greater risk of failure as power lines sag and expand and transformers overheat. Grid hardening solutions such as upgrades to transformers and substations, and burying or changing materials for distribution lines, can build resilience.[13] For businesses that rely on the grid, distributed and backup energy resources such as rooftop solar, battery energy storage systems (BESS), generators, and microgrids, can help reduce stress on the grid and provide backup power during outages, ensuring that critical operations continue even when the central grid is under strain. Smart meters and Internet of Things (IoT) sensors may also provide businesses with insights to enable predictive maintenance and early detection of potential failures.

Learn More & Connect

For more information on protecting your business, contact your local risk engineer, visit the Chubb Risk Consulting Library, or check out www.chubb.com/riskconsulting.

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