WHITE PAPER

Constructing Tomorrow: Sustainability and Resilience in Civil Engineering

Incorporating sustainable and resilient design into building practices is a focus of civil engineers. However, there are different interpretations of the concepts and gaps in how to effectively incorporate these strategies and additional data needed to help make sustainability and resilience practical and useful in the industry.

The principles of civil engineering are as solid as the structures they produce. From the Great Pyramids to the Eiffel Tower, or the Hoover Dam to the Panama Canal, civil engineers understood the foundation, developed the design, sourced the materials and built the structures. These essential areas of knowledge have produced the infrastructure society relies on every day.

Yet even as the underlying principles of civil engineering remain the same, the world in which civil engineers operate has changed. The rising demand for and growing scarcity of construction materials, the environmental impact of building, extreme weather events, and a changing climate are impacting infrastructure design and construction.

According to the World Green Building Council, building construction and operations account for 39% of energy-related carbon emissions globally. Civil engineering strives to address these emissions by embracing sustainable, resilient design and building strategies. However, adapting and incorporating new concepts and methods into civil engineering may be easier said than done.

The ancient practice of civil engineering leverages time-tested theories and introduces new, often subjective, concepts that may prove challenging. But the effort to make sustainability and resilience practical and useful across all civil engineering disciplines is time well-spent.

Sustainability Versus Resilience

Introduced in the Brundtland Report in 1987, the concept of sustainability is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The report also notes that “sustainability requires a clear focus on conserving and efficiently using energy.” Sustainability refers to using our finite resources wisely to conserve them for future generations.

According to the U.S. Global Change Research Program, resilience is a “capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.” Resilience focuses on preparing for the unpredictable, including fire, seismic and weather events, and flooding.

There is continued debate in the civil engineering community about these terms but appreciation that leveraging and balancing both sustainability and resilience can make a project stronger.

Mind the Gap

There are many interested parties involved in any civil engineering process. Federal agencies, state regulators, municipal permitters and the local community are often affected and communication is key to success. However, weaving sustainability and resilience into a project is not always easy.

The gap between academic research and the front lines of engineering practices is not yet fully aligned in all areas. Similarly, state priorities may not align with a proposed project in terms of environmental impact and preparedness. And communities that may end up funding projects are not always actively informed about including sustainability and resilience in infrastructure projects and the resulting advantages or impacts.

For civil engineering and construction companies, performance codes for buildings and lifeline systems don't specify how resilience and sustainability must be addressed. Standards for components and systems are not necessarily aligned with the goals of environmentally focused construction, leaving designers without necessary guidance. Life cycle analysis of infrastructure is missing on many projects, which creates a gap in new design practices and projections against the actual life of the asset.

The gaps must be thoroughly identified and addressed for infrastructure projects to achieve sustainability and resilience. Clear guidelines, codes and requirements will enable civil engineers to prepare a consistent scope of work on projects to competitively bid and manage project costs.

The Data to Deliver

Connecting sustainability to all civil engineering disciplines will take cooperation, communication, alignment and more data. A more defined framework in the civil engineering practice to codify and incorporate strategies will help create sustainable and resilient infrastructure.

To close the gaps, create the codes and help civil engineers effectively deliver projects requires more information and data, such as:

- A systems analysis, to understand how sustainable and resilient engineering is performing.
- A start-to-finish analysis for services, such as water and power, to establish common performance goals.
- An interdependency analysis for city infrastructure and services, to define performance metrics.
- Cost analysis and guidance for incorporating resilience and sustainability into a design for public and private infrastructure.

Climate resilience is also a nexus topic between sustainability and resilience. As such, the data needs require translation of national climate data into a useable approach for civil design engineers. Fortunately, the National Oceanic and Atmospheric Administration and the American Society of Civil Engineers have begun a strong collaboration to address this need.

Conclusion

The intersection of sustainability and resilience in civil engineering is not always easily identifiable. The wider community must be in alignment to achieve clarity and proactively bring these essential concepts into practice. Acknowledging the differences in definitions, identifying the gaps, and building the necessary codes and guidance based on data are good places to start.

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