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Building information modeling and sustainable design for civil engineers

By Adam Strafaci

Green or sustainable design comes up in nearly all my conversations with civil engineers. I'm also hearing more and more about building information modeling (BIM), but many of the engineers I talk with are still wrestling with trying to get their arms around BIM and what it means for them.

First, don't get hung up on the "building" part of BIM. Rather, think of it as a process with principles that apply to civil engineering. BIM can be defined as an integrated process built on coordinated, reliable information about a project from design through construction and into operations. While BIM is widely accepted in architecture and construction, its benefits are just as relevant for civil engineering projects.

Using BIM software, like Autodesk's AutoCAD Civil 3D, civil engineers can more easily predict the outcome of their projects before they are built. By creating coordinated, reliable design information, civil engineers are able to respond to changes faster; optimize designs with analysis, simulation, and visualization; and deliver higher quality construction documentation. Starting with surveying and all the way through to supporting construction processes, BIM allows the extended civil engineering team to extract valuable data from the model to facilitate earlier decision making, more sustainable designs, and faster, more economical project delivery.

This approach is essential for sustainable design, which requires the integration, analysis, and optimization of environmental, social, and economic factors for the life of the project. With traditional drafting-based design processes, the civil engineer often delivers the first design that meets code, but this is not necessarily the best design. Analyzing the impact of multiple alternatives and testing them against multiple criteria just takes too long. Using BIM, the civil engineer can evaluate multiple design options quickly and can use integrated analysis tools, such as geospatial and stormwater analysis, to come up with a solution that balances environmental impact, social factors, and cost effectiveness.

Most progress in sustainable design has been made within the land development market. The U.S. Green Building Council Leadership in Energy and Environmental Design New Construction (LEED-NC) and the pilot Neighborhood Development (LEED-ND) rating systems both include credits for design tasks that are driven by the civil engineer. Here are three examples of how civil engineers can leverage BIM software to achieve LEED credits.

Smart location

One of the goals of sustainable land development is to reduce the environmental impact of urban sprawl by encouraging development within existing communities. This helps conserve natural and financial resources that are required for construction and maintenance of new infrastructure. Smart location is primarily a geospatial problem and can be facilitated by integrating geospatial data and analysis into the design process.

For example, LEED credits can be earned for locating a site in high-density areas. Using BIM software, the civil engineer can overlay the site design with a street centerline file of the surrounding area and use a geospatial buffer analysis to identify quickly the streets within a 1-mile radius of the proposed site. Queries can then be done to determine the total length of road in the buffer area to compute density and determine if it meets the criteria for credits.

Stormwater management

Another example of BIM use for sustainable design is with stormwater design. Traditional stormwater management systems are designed to move water off a site as quickly as possible. This can lead to increased pollution, flooding, erosion, and other environmental problems. There is now a shift toward more sustainable stormwater management practices that minimize erosion, encourage natural infiltration, and recharge aquifers. Employing best management practices (BMPs) such as permeable pavements, rain gardens, bioswales, and infiltration basins is becoming standard practice. The integration of hydraulic and hydrologic analysis with civil engineering design models makes it much easier for civil engineers to evaluate the environmental impacts of BMPs and determine the most sustainable solutions. Both LEED-NC and LEED-ND provide credits for sustainable stormwater management practices.

Steep slope protection

A third aspect of sustainable design is steep slope protection, the goal of which is to minimize erosion, protect established habitats, and reduce stress on natural water systems by preserving the natural and vegetated state of steep slopes. Using the geospatial analysis and mapping capabilities that are integrated with a design model, engineers can quickly query the surface data and visually display the areas of the site that are classified as steep. When an engineer starts evaluating grading scenarios to improve the site, he or she can get instant visual feedback to see if the changes impact the sensitive areas.

In summary, sustainable design is gaining momentum with civil engineers, and it is quickly shifting to standard practice. BIM enables sustainable design for civil engineers by allowing them to evaluate more design alternatives and integrate analysis into the design process.

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