Structural Engineers and... Energy Codes?

By Jim D'Aloisio, P.E., SECB

I recently asked a group of about 20 structural engineers in Pittsburgh if they thought that structural engineers have any role in addressing energy code requirements. Less than half of them responded affirmatively – this was apparently the first time that many of them had considered such a notion! So we explored the topic further.

Perhaps the disconnect begins with the way we "frame" our profession (pun intended). If engineers who provide structural services for building design projects identify themselves as the project's "structural engineer," it implies their role on the project is limited to ensuring the load-resisting integrity of beams, columns, foundations, the lateral system, and other primary or secondary structural items. The truth is, on most successful building projects with which I have been involved, our role might have been better defined as the project's *consulting structural engineer* – implying not just the design of the structural components but a willingness to consult on nonstructural aspects of the project that relate to the building structure. This includes not only deflection and vibration, but acoustics (ever specify an acoustic roof deck?), aesthetics (such as Architecturally Exposed Structural Steel or appearance-grade concrete forms), and yes, the effect of the structure on the thermal performance of the building envelope.

We once worked on a project where our scope carefully limited our role to providing the structural design for wind and gravity load resistance of the building facade elements, specifically excluding any other performance aspects of the exterior envelope. The wall system involved cold-formed steel studs and hat channels, horizontal aluminum channel girts, and thin cementitious rain screen panels. The structural design requirements were met but the energy performance was subpar, primarily due to the thick aluminum girts (aluminum conducts heat about five times better than carbon steel) that thermally bridge across the mineral wool insulation. Because of our carefully worded scope, we were clearly not culpable for the problem. However, we were in as good a position as anyone on the design team to identify this condition as problematic and help develop more appropriate solutions.

Here are a few items to consider:

- Is compliance with the *Energy Code* any less important than compliance with the *International Building Code* (IBC)? Of course, a structural engineer must consider the structural portions of the IBC of paramount importance to their work in assuring safety, integrity, and reliability. So how can energy efficiency be considered in the same category of importance? Well, the fact is, the project must conform to all parts of the applicable building codes – Code requirements are code requirements.
- For those structural engineers who feel the design and detailing of a building envelope is a task for others, how many engineers have shown a vapor barrier under a slab-on-grade? The purpose of this barrier is to mitigate vapor migration through the building envelope. It has nothing to do with the structural performance. In this way, we have incorporated building science principles into our designs for years.
- Some structural engineers show foundation insulation in climate zones where it is appropriate, and some do not. The problem develops when the insulation integrates with, or interrupts, the foundation and perimeter slab edge detail. Building envelope professionals now realize that minimizing thermal breaks in continuous insulation can significantly affect the energy loss through the envelope, as well as reduce the potential for condensation, material deterioration, and organic growth, increase occupant comfort, and can be an essential aspect of compliance with energy code requirements.
- A serious issue developed with steel shelf angles while we were not paying attention: the prevalence of continuous wall insulation has obliged us to design these elements with thick, horizontal projecting legs that span across the insulation layer to support masonry veneer. Ironically, these conditions allow tremendous building energy loss due to thermal bridging of the steel angle. These thick, continuous, conductive plates through the insulated envelope are essentially prohibited by European Union energy codes, which set clear limits to the amount of thermal bridging allowed. The U.S. should follow suit. In fact, such details may make compliance with the *ICC Energy Conservation Construction Code* and ASHRAE 90.1 requirements extremely difficult. Alternatives include vertical discrete steel "fin plates" that extend across the insulation plane and support a smaller-sized angle from the spandrel beam or the careful use of nonconductive shims at supports. Recently completed research should soon provide helpful design guides to practitioners.
- Many other structural conditions at the building perimeter warrant consideration of thermal transfer effects, including balconies, canopies, lintels, steel-framed roof overhangs, and cold-formed steel framing conditions. These represent opportunities to actively engage with architects, owners, and other members of the design team to address these details, which can lead to very positive results. Coordinating building perimeter details with the need for continuous air barriers, which are different than vapor barriers, is a new frontier for project team collaboration. Should this nonstructural design consideration change what we do structurally? Perhaps not, but it depends on the building system being used. Awareness of this requirement, when it is necessary or appropriate, and how the architect or others intend to address it, is the first step.

Considering the discussion above, I share the following opinion:

> *Structural engineers who design building structures should have a basic working knowledge of building science, and how a building's structure influences heat transfer through the building envelope.*

It may seem radical to some and rational to others, but hopefully, this provides a useful perspective in your approach to structural design. As a licensed Professional and Structural Engineer, it is important to have a high level of control in what is designed and constructed under one's stamp. Accordingly, structural details to improve the energy performance of the building envelope should be done by the Structural Engineer. A truly integrated design is the path to better buildings.▪

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