construction issues

Anchoring MEP Items into Suspended Slabs

By Christopher Lesher, P.E.

Coordination is an integral part of every project. The structure must be adequate to support the imposed loads, but it must also be integrated with the architectural features and mechanical, electrical, and plumbing (MEP) items. While there are many issues which could be discussed on this topic, this article focuses on two which are often not adequately addressed in construction documents: suspending MEP items from floors and roofs, and embedding MEP items in slabs. This discussion is based on steel-framed buildings with metal roof deck and concrete floor slabs on metal deck.

Structural drawings are often issued with notes pertaining to allowable MEP loads, but with little other information addressing MEP coordination. The MEP specifications may include some typical information to address suspending items from floors or roofs, or embedding items in slabs, but there may be little consideration for what effects this may have on the structure. These specifications may be performance-based, leaving the contractor to choose what they think will work best, but the result may adversely affect the structure. These items need to be coordinated during the design process among the structural engineer, MEP engineer, and architect to avoid problems and delays during construction.

Suspended MEP Items

MEP items are dead loads, and some nominal amount (5 or 10 psf) needs to be included in the design of the primary structural framing. This load should be specifically noted on the structural drawings as "Mechanical Equipment and Piping Suspended from Structural Framing". If the MEP engineer is aware that certain areas require additional load, the structural engineer must be notified of the weights and locations by the MEP engineer. Suspended mechanical units certainly fall into this category, but large pipes or groups of pipes and conduit can be significantly heavier than the nominal MEP load and are often overlooked.

"…the structural engineer must be notified of the weights and locations by the MEP engineer."

Suspended items will act as concentrated loads on the structure. They may be hung from beams, joists, or floor slabs, but there are limitations for each. The following criteria must be coordinated and clearly noted in both the structural and the MEP construction documents.

•Concentrated loads shall be limited to those which induce moments and shears in members not greater than those induced by the noted uniformly distributed loads. Staggering suspension points is one method of satisfying this criterion.

•Do not suspend concentrated loads in excess of 50 pounds each from composite slabs on metal deck. Post-installed anchors, such as expansion anchors, are very popular because installation only requires drilling through the deck and into the slab wherever a hanger is needed. However, there are a few problems with this.

1. While a composite slab does have the ability to support concentrated loads, this ability is much more limited than that of a beam. The slab thickness and floor deck vary from job to job, and each combination of deck and slab has a different capacity.
2. The capacity of post-installed anchors is limited by embedment and edge distance. Anchors installed in the low deck flutes have little edge distance. Anchors installed in the high flutes may have insufficient embedment. There is also a risk of drilling through the slab or hitting reinforcing.
3. Most manufacturers of post-installed anchors do not have test data nor load tables for using their anchors in slabs on deck. If suspended loads in excess of 50 pounds must be hung from slabs on deck, pull-out tests must be performed to verify anchor capacity. A preferable alternative would be to suspend loads from beams or from supplemental framing.

•Do not suspend concentrated loads from roof deck. Loads suspended from a roof structure must either be suspended from roof framing or from supplemental framing.

•Supplemental framing is indicated in the MEP drawings and specifications. Supplemental framing consists of struts, angles, or channels which are supported by the structural framing. This supplemental framing is not part of the structural contract and must be included in the MEP contract and specified by the MEP engineer. Alternatively, the MEP engineer can write a performance specification requiring the contractor to hire a structural engineer to design these supports.

•Seismic bracing of suspended MEP items is indicated in the MEP drawings and specifications. Suspended MEP items may need to be laterally braced, depending on the Seismic Design Category and importance of the building. If the MEP engineer does not have the expertise needed to design seismic bracing, a structural engineer can be hired, or a performance specification could be written requiring the contractor to hire a structural engineer to design the necessary bracing.

•MEP loads supported by steel joists (whether hung or bearing) must be given in the construction documents. A structure is designed by the structural engineer, but joists are designed by the joist manufacturer. Specific loads and locations must be coordinated and given in the construction documents. Weights, sizes, and locations of

suspended or rooftop units must be carefully reviewed when submitted and compared to the weights, sizes, and locations used for design. Just because a substitution is acceptable for MEP requirements does not mean it satisfies and is acceptable for the structural requirements. Increased weight or changes in size or location may be cause for rejection of the submittal since additional analysis would be required and additional cost may be incurred by the engineer and the manufacturer.

•Locate concentrated loads on steel joists at panel points. Where this is not possible, web reinforcing must be installed for loads which exceed 100 pounds.

Embedded MEP Items in Slabs:

The most common non-structural embedment in slabs is electrical conduit. MEP engineers sometimes specify this as a requirement, and contractors will sometimes prefer to embed conduit under the premise of "that's how we've always done it". However, embedding conduit in slabs can cause problems, particularly in slabs on deck since the concrete thickness above the deck is usually small (2.5 to 3.5 inches). Avoid embedding conduit or other non-structural items in slabs wherever possible. If unavoidable, the following guidelines should be considered by MEP engineers when laying out embedments:

•Limit the size of non-structural embedments to a maximum of one-third of the thickness of the slab. For a slab on grade this would be one-third of the total slab thickness, but for a slab on deck this would be one-third of the concrete cover above the deck. A maximum outside diameter of 1 inch is a good rule of thumb.

"…embedding conduit in slabs can cause problems…"

•Lay out embedments so that non-structural items do not cross over each other. Embedment thickness at crossovers will likely exceed the maximum thickness permitted by ACI and can interfere with the placement of slab reinforcing.

•Space embedments at least 18 in. apart.

•Provide at least 3/4-inch concrete cover between embedded items and slab surface, deck, screed angles, edge forms, or reinforcing bars. In exterior slabs, provide at least ½-inches concrete cover between items and exposed surfaces.

•Do not lay embedments on deck (especially not in the lower flutes of composite deck) nor on reinforcing bars. The embedment may affect the bond of the concrete with the deck or rebar, thereby reducing the structural strength.

Securely position items by wire tying to support chairs.

•Do not embed aluminum items unless they are coated to prevent galvanic reaction with concrete and steel.

•At penetrations for plumbing in slabs on deck, install PVC sleeves. To avoid cutting slab reinforcing, do not core-drill.

•Do not locate embedments in slabs on grade at the bottom of the slab. Items should either be completely embedded in the slab or completely buried in the slab subbase.

•Items such as trench ducts and electrical floor boxes require special consideration.

In summary, the MEP drawings and specifications need to be coordinated with the structural drawings and specifications. The discussed information must be coordinated during the design process among the structural engineer, MEP engineer, and architect to avoid conflicts, delays, and additional costs during construction.■

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