

**January 14, 2006**

# **SUMMARY REPORT**

for the meeting of an

## **INTER-INDUSTRY WORKING GROUP**

on

## **REDUCING THE COST OF TOLERANCE COMPATIBILITY PROBLEMS**

**Organized and Hosted by**

**American Society of Concrete Contractors  
St. Louis, Missouri**

**and held in**

**St. Louis, Missouri, February 17-18, 2005**

## **CO-SPONSORS**

**American Architectural Manufacturers  
Association**

**American Concrete Institute**

**American Institute of Steel Construction**

**American Society of Civil Engineers  
Construction Institute**

**Concrete Reinforcing Steel Institute**

**Floor Covering Installation Contractors  
Association**

**Portland Cement Association**

**Post-Tensioning Institute**

**Strategic Development Council of the ACI  
Concrete Research and Education Foundation**

## **INTRODUCTION**

This summary report from a meeting of the Inter-Industry Working Group on Reducing the Cost of Tolerance Compatibility Problems was prepared by Ward R. Malisch, American Concrete Institute, and Bruce A. Suprenant, Concrete Engineering Specialists. Malisch and Suprenant collaborated in initial planning of the meeting, sponsored and hosted by the American Society of Concrete Contractors (ASCC), and agreed to prepare a written summary of the meeting. This summary is not a consensus document, nor does it represent the views of ASCC, the American Concrete Institute, Concrete Engineering Specialists, or any of the other organizations and firms represented at the meeting. The summary is intended to specifically identify problems related to tolerance incompatibility between adjacent structural elements installed by different trades.

## **BACKGROUND**

The following excerpt from ACI 117R-90, “Commentary on Standard Specifications for Tolerances for Concrete Construction and Materials” summarizes the need for construction tolerances, and some principles that should be applied in selecting tolerances:<sup>1</sup>

“No structure is exactly level, plumb, straight, and true. Fortunately, such perfection is not necessary. Tolerances are a means to establish permissible variations in dimensions and location, giving both the designer and the contractor parameters within which the work is to be performed. They are the means by which the designer conveys to the contractor the performance expectations upon which the design is based or the use of the project requires. Such specified tolerances should reflect design assumptions and project needs, being neither overly restrictive nor lenient. Necessity rather than desirability should be the basis of selecting tolerances.”

In a 1977 paper entitled “European Concepts of Construction Tolerances,” Holbek and Andersen made the following observations specific to tolerances for interfacing materials:<sup>2</sup>

“It does not appear to the authors that any agency in North America has stated to develop overall building tolerances. Individual material groups such as steel and concrete have developed some tolerances for their products but have had little success on the subject of interfacing these with other materials. Designers ought to solve such interfacing by specifying material tolerances and allowing realistic clearances between different components, but have had little input in the form of realistic tolerance proposals or standards to guide them.”

Nearly 30 years later, tolerances for steel, cast-in-place and precast concrete, masonry, and other materials have been produced as a means for establishing permissible variations in dimension and location of building components. But the issue of conflicting tolerances

at the interfaces between different materials has not been satisfactorily addressed. Examples of such interfaces include structural steel to cast-in-place concrete, flooring installed on concrete floors, precast/prestressed concrete members bearing on cast-in-place or structural steel members, and metal curtain walls or partition walls interfacing with structural frames. Even when all components are within their industry-specified tolerances, incompatibility of the tolerances for interfacing materials can result in components that don't fit. This can then result in claims, counterclaims, and litigation. The increases in cost caused by such disputes can be felt by all members of the construction team because someone has to pay when construction components don't fit.

## **SPECIFICATION DIVISION INCOMPATIBILITIES**

Tolerance incompatibility problems can occur whenever materials in the following specification divisions interface:

- Division 3 Cast-in-place Concrete
- Division 4 Masonry
- Division 5 Metals
- Division 8 Doors and Windows
- Division 9 Finishes
- Division 14 Conveying Systems
- Division 15 Mechanical
- Division 16 Electrical

Some specific problems are as follows:

- Reinforcement and tendon placement  
Tolerances differ for placement of nonprestressed and prestressed reinforcement. Yet prestressing tendons are positioned by tying them to in-place reinforcing bars, resulting in tendons not being placed within the specified tolerance.
- Anchor bolt placement  
ACI tolerances in Division 3 for vertical, lateral, and level alignment of items embedded in concrete (such as anchor bolts) are less restrictive than AISC tolerances for anchor bolts in Division 5. This can lead to disputes between the steel erector and concrete contractor as to who pays for needed adjustments.
- Weld plate placement  
ACI and AISC also have different tolerances for the required positioning of weld plates used for connections between steel and cast-in-place concrete structural members. The difficulties in placing weld plates within *any* tolerance is exacerbated when the concrete structural member is heavily reinforced, because the studded anchor rods must fit between reinforcing bars..
- Floor flatness  
Concrete floor finish specifications in Division 3 don't match those in Division 9. Because of a difference in measuring systems (F-numbers for Division 3 and gap under a 10-ft straightedge for Division 9) and changes in floor flatness with time due to curling, the floor placed by the concrete contractor often doesn't meet the needs of the floor-covering installer.

- Americans with Disabilities Act (ADA)
  - The ADA typically specifies minimum and maximum dimensions and slopes for ramps and sidewalks, but ACI doesn't include tolerances for sloped surfaces.
- Stairs
  - Cast-in-place stair tolerances differ from precast stair tolerances, and neither can effectively accommodate tolerances in the slab elevations at the bottom and top of the stairs.
- Wall Finish – Painting/Coating/Plaster
  - ACI 117-90 requires the relative alignment for a concrete wall to 3/8 in. in 10 ft or better. Plaster specifications reference ASTM C 92, "Standard Specification for Application of Portland Cement-Based Plaster," which requires the concrete surface to be within 1/4 in. in 10 ft.
- Dry wall installation
  - ACI 117-90 requires the relative alignment for a concrete wall to 3/8 in. in 10 ft or better. ASTM C 840, "Standard Specification for Application and Finishing of Gypsum Board," requires that all framing members and substrate be installed so that after the gypsum board has been applied, the finished surface will be in an even plane.
- Mechanical and electrical inserts
  - ACI 117-90 requires a slab thickness tolerance of +3/8 in. and – 1/4 in., except when an elevated floor is specified as level. Mechanical or electrical inserts for penetrations attach to the formwork, are sized to the exact design thickness of the floor, and may be covered with 3/8-in. or more concrete during placement. This requires the mechanical or electrical contractor to chip out concrete at the inserts.
- Curtain wall installation
  - ACI 117-90 gives a 3/4-in. level alignment tolerance for the top of concrete floors and the bottom of concrete surfaces supported by forming. Floor-to-ceiling metal curtain walls or partitions must have connection details that allow for an opening up to 1 1/2 in. larger or smaller than the plan dimensions. Smaller openings are particularly costly to correct if concrete removal is required.
- Elevator tolerances
  - The ACI 117-90 vertical alignment tolerance is 1 in. for concrete wall heights less than 100 ft and 1/1000 times the height but not to exceed 6 in. for walls exceeding 100 ft tall. The National Elevator Industry requires a clear hoistway, plumb from top to bottom, with variations not to exceed 1 in. at any point in the first 100 ft. Tolerance may increase at 1/32 in. for each additional 10 ft up to a maximum displacement of 2 in. Minimum required hoistway opening dimensions are sometimes shown in elevator manufacturers' drawings. Using these minimum dimensions doesn't permit any concrete wall tolerance that makes the opening smaller. The National Elevator Industry maximum tolerance of 2 in. is at odds with ACI 117 maximum of 6 in.

- Concrete surface appearance tolerances
 

A smooth-form finish is often specified for formed concrete surfaces. The specification may state that the form facing material shall produce a smooth, uniform texture on the concrete without defining the meanings of either “smooth” or “uniform.” Specifications for a smooth form finish may also require patching of tie holes and defects, without defining “defects.” Concrete contractors believe that surface air voids (called bugholes) are a normal occurrence in vertical surfaces and are not a defect unless they’re unusually large. But for smooth-form finishes that will receive a coating, the coating applicator may insist that all bugholes must be filled because they may cause pinholes to develop in the coating. Concrete contractors counter that if a bughole-free surface is needed, a smooth-rubbed or grout-cleaned (sacked) finish should have been specified.

### **PURPOSE, PARTICIPANTS, AND PRESENTATIONS**

Dealing with tolerance incompatibility problems after they occur is costly, and often results in construction disputes, claims, and litigation. Prevention of such problems makes good sense economically, but requires input from all members of the construction team. This meeting of an Inter-Industry Working Group was convened to collect the input. At the meeting, participants representing technical institutes, trade associations, contractors, and design professionals were asked to identify the highest priority tolerance-incompatibility problems, and start working toward solutions. A list of attendees is attached as Appendix A.

Members of the American Concrete Institute, American Institute of Steel Construction, Precast/Prestressed Concrete Institute, American Architectural Manufacturers Association, Floor Covering Installation Contractors Association, and American Society of Concrete Contractors gave presentations that outlined concerns related to tolerance compatibility issues. These included the following:

- Tolerance requirements are not always clearly written and are thus subject to differing interpretations by members of the construction team. Intent of the tolerance must be understood in order to interpret it correctly.
- Multiple tolerances for the same structural component, such as a column, create disputes about which tolerance controls.
- Some tolerances are not economically achievable, nor do they need to be. As-built measurements show that such tolerances have not been met, yet the structure performs acceptably.
- Because there are no measurement protocols for many tolerances, disputes about conformance with tolerances sometimes result.
- A statistical approach to determining conformance with stated tolerances is needed.
- When structural steel frames must be connected to concrete cores, connections must be designed to accommodate ACI 117 tolerances for lateral alignment and plumb, and AISC tolerances for beam length. This may require oversized embeds and connections with long slots to allow for adjustments.

- Steel connections may require three-dimensional adjustability when steel and concrete dimensions are at their tolerance extremes.
- Anchor bolts embedded in concrete for steel connections may be incorrectly positioned—laterally or vertically—or may be bent after being correctly placed. Field solutions are often available, but increase cost.
- Details at the interface between precast cladding panels and the structural frame are critical. Cladding must be capable of being set and adjusted later.
- For precast cladding operations, the structural engineer does the slab drawings and the architect does the cladding details. The concrete contractor who builds to the structural drawings often doesn't see the cladding details. But if the detail allows little or no tolerance, and the slab is built to common ACI 117 tolerances, panels may not fit and the concrete contractor is blamed.
- Continuous brick coursing across precast columns creates tolerance issues that can be avoided by omitting bricks at the columns while preserving the architectural intent.
- Windows, doors, and curtain walls in concrete openings must be designed to accommodate construction tolerances and building movement after construction.
- Three-way adjustment is needed to allow for alignment changes. Field fixes to accommodate out-of-tolerance openings may not be structurally sound or allow the needed movement after construction.
- Doors and windows that open and close require especially tight tolerances to operate properly.
- Out-of-square or out-of-plane racking interferes with operation of windows and doors, mars appearance, and decreases resistance to water and air infiltration.
- Installation costs for windows, doors, and curtain walls increase when openings are too large or too small, embeds are improperly located, or floor edges or columns are not properly aligned.
- Finish flooring flatness issues can be directly traced to differing tolerances required *of* the concrete contractor and *by* the flooring installer.
- Project documents should clearly indicate how tolerance measurements will be made, who will make them, what corrective actions are needed when tolerances are exceeded, and who is responsible for taking the corrective actions.

The last bullet item emphasizes an important point made during the meeting:

***Communication among construction team members must be improved, and high quality project documents are the means by which this can be accomplished.*** The examples of specification division incompatibility refer primarily to specifications, but the role of drawings, and especially details, should also be cited.

## DESIGN DETAILS ARE CRITICAL

Design professionals, fabricators, and manufacturers can specify details that take some tolerances into account. In fact, good details are one key to avoiding tolerance conflicts.

All construction drawings require details that show the interface between components installed by different trades. These components vary in size and in position within the finished structure, so the details must have realistic provisions for adjustments at the jobsite. Provisions are realistic when the detail accommodates expected variations (tolerances) without requiring excessive rework. Unrealistic provisions may result in field alteration of the detail that impairs the function of the structure. Sometimes the tolerances are stated in the specifications, but they may be based on established trade practices. In either case, if the detail allows for adequate tolerances and the builder meets them, cases of excessive rework or faulty field alterations are less likely to occur.

How should good design details be prepared? Several steps are needed:

- Determine how much each component can be expected to vary in size and position. Sometimes, standard tolerances for size and position can be found in the same document—for example reinforcing bar dimensions and placement as given in ACI 117-90. More often, expected variation in component size—such as a weld plate—may be found in one document, while expected variation in position may be found in one or more documents.
- Consider the order in which the structure will be built and ask what the result will be for placing other components if the first component is placed at the extreme location allowed by stated tolerances. For instance, in the curtain wall example described in the section on Specification Division Incompatibilities, if the surface of one cast-in-place concrete floor is as high as allowed, and the soffit of the floor above it is as low as is allowed, will the adjustment in the curtain wall accommodate this difference? A better question may be: “Should the curtain wall be expected to accommodate the difference?” Adding individual tolerances and expecting the components to fit may lead to impractically large required adjustments. So this is not a simple question to answer. A statistical approach is needed, in which details would be expected to accommodate a given variation—say 1 in.—but it is also expected that the variation will be exceeded and require correction some percentage of the time. The specifier and contractor would then be better able to decide how to balance the cost of correction against the cost of precision layout and perhaps more rigid formwork.
- Consider the relative costs of specifying narrower ranges of tolerances or wider adjustment capabilities in components. This requires an understanding of whether or not reductions or adjustment capabilities are physically possible.
- Revise the detail as needed to optimize overall construction costs.

This rational process for producing design details can be successfully implemented only if the designer has the tolerance information for each component, understands the construction sequence, and makes adjustments where needed. Time may not permit such a structured approach to the problem, and off-the-shelf details may be used. A possible

solution for this is a standard approach to details for components most likely to exhibit tolerance incompatibility. Such component would include stairs, windows, elevators, and facades such as brick veneer or precast concrete.

### **JOBSITE CONSIDERATIONS**

Even with good details, problems at the interfaces of materials placed by different trades can occur. These are sometimes due to mistakes rather than tolerance issues, and can be grouped into the following categories:

- Failure to refer all measurements back to a common datum. Fit problems are more likely if different trades use different benchmarks or control points.
- Use of the correct embeds, such as weld plates and anchor bolts, but placed in an incorrect location (out of tolerance).
- Incorrect embeds used at the location; e.g. weld plate properly located, but is too small.
- Damage to connecting elements; e.g. anchor bolts that are bent after installation.

These mistakes can generally be avoided by careful field engineering and inspections before the concrete placement, and protection of installed fittings after placement.

### **RECOMMENDED ACTIONS**

Tolerance incompatibility problems can be addressed during the preparation of construction drawings and specifications. But addressing these problems requires the services of a “master builder” who understands the construction process and the limitations involved. In the past, the architect was expected to fill the role of “master builder.” In a design-build delivery system, avoiding tolerance incompatibility problems is a shared responsibility of the design professional and the contractor. For design-build-bid delivery systems, the building team includes a design professional, a construction manager or general contractor, and several subcontractors. In this case, the responsibility for addressing tolerance incompatibility issues is often not clearly defined. For pure construction manager delivery systems in which the CM doesn’t self perform any of the work, if field personnel are not familiar with how a structure is built, they are also less likely to anticipate tolerance incompatibility problems. Given these circumstances, production of good details is critical.

In the design-bid-build delivery system, one person on the design team should be assigned the task of evaluating interfaces of different building materials and trades and preparing design details that include reasonable tolerances. This person should have a knowledge of how structures are built or have input from a builder. Pages 5 and 6 of the attached construction tolerance article from Canada<sup>3</sup> (Appendix B) illustrate a good approach to detailing for a brick veneer wall supported on steel shelf angles on a multistory concrete building. Similar discussion of standard details for interfaces of structural steel and concrete, prefabricated stairs and cast-in-place concrete, and curtain walls or windows in precast or cast-in-place concrete would be useful to design professionals.

College coursework for design and construction professionals should also include discussions of issues related to construction tolerances. Although the skills for dealing with tolerances will be honed in the field, exposure to tolerance issues in the classroom would be valuable.

Work is still needed in developing reasonable tolerance specifications. Some of the concrete tolerances in ACI 117 are not based on as-built data and thus may set an unachievable standard. Methods for measuring tolerances haven't been standardized, so the contractor may be a victim of capricious enforcement of tolerance specifications. Most importantly, many tolerances are stated as absolute values, when a statistical approach to tolerances is needed. These same criticisms are applicable to tolerances published by other organizations.

## SUMMARY

Each manufacturer or trade for a building project may meet tolerances given in the specifications, but some rework will still be needed before the project is satisfactorily completed. To avoid *excessive* rework, tolerances in each specification division need to be harmonized. If the door manufacturer needs a floor flatness tolerance of 1/16 in. in 3 ft, and the concrete contractor's specification requires a flatness tolerance of 1/4 in. in 10 ft, the door tolerance may have to be relaxed, the floor flatness tolerance tightened, or a jobsite adjustment may be needed to accommodate the mismatch. Relaxing a tolerance may result in the manufactured product not operating properly. Tightening a tolerance or providing an adjustment mechanism may increase construction cost. Optimization is needed to provide satisfactory performance at reasonable cost.

Optimization requires **better communication** among the people who manufacture the components used in construction, those who design the structure, and those who install the components. Construction documents—specifications and drawings—are the means for communication. More input from suppliers and contractors when construction documents are developed will improve communication.

## REFERENCES

1. "Commentary on Standard Specifications for Tolerances for Concrete Construction and Materials (ACI 117R-90)," American Concrete Institute, Farmington Hills, MI, 1990, p. 117R-1.
2. Holbek, Kai, and Anderson, Povl R., "European Concepts of Construction Tolerances," *ACI Journal*, Mar. 1977, p. 107.
3. "Construction Tolerances," Prepared by the Canada Mortgage and Housing Corporation, Research Division, and available on their Website at (<http://www.aaa.ab.ca/pages/members/media/Tolerancesenwa.pdf>)

**APPENDIX A**  
**Inter-Industry Working Group**  
**Construction Tolerance Incompatibility Issues Attendees**

**Rodney D. Adams**

United Forming, Inc.  
470 Riverside Parkway  
Austell, GA 30168  
Tel: 678-945-4224  
E-Mail: [radams@unitedforming.com](mailto:radams@unitedforming.com)

**Dennis Ahal**

Ahal Contracting Co., Inc.  
3746 Pennridge Drive  
St. Louis, MO 63044  
Tel: 314-739-1142  
E-Mail: [dahal@ahal.com](mailto:dahal@ahal.com)

**Scott M. Anderson**

Pankow  
2101 Webster St. #1500  
Oakland, Ca 94612  
Tel: 510-893-5170  
E-Mail: [sanderson@pankow.com](mailto:sanderson@pankow.com)

**Rick Bohan**

Portland Cement Association  
5420 Old Orchard Road  
Skokie, IL 60077  
Tel: 847-972-9038  
E-Mail: [rbohan@cement.org](mailto:rbohan@cement.org)

**Bret Burkhart**

Hensel Phelps Construction Company  
2505 Darren St.  
Fort Collins, CO 80524  
Tel: 970-381-9503  
E-Mail: [burkhart007@msn.com](mailto:burkhart007@msn.com)

**\*Charles Carter**

American Institute of Steel Construction  
One East Wacker Drive Ste 3100  
Chicago, IL 60601-2001  
Tel: 312-670-2400  
E-Mail: [carter@aisc.org](mailto:carter@aisc.org)

**Rex C. Donahey**

*Concrete International*

American Concrete Institute

38800 Country Club Drive

Farmington Hills, MI 48331

Tel: 248-848-3752

E-Mail: [rex.donahey@concrete.org](mailto:rex.donahey@concrete.org)

**George Dryden**

United Forming, Inc.

470 Riverside parkway

Austell, GA 30168

Tel: 678-945-4224

E-Mail: [gdryden@unitedforming.com](mailto:gdryden@unitedforming.com)

**Ron Eldridge**

Sundt Construction

2630 S. 20<sup>th</sup> Place

Phoenix, AZ 85036

Tel: 602-920-6998

E-Mail: [reldridge@sundt.com](mailto:reldridge@sundt.com)

**Al Engelman**

Engelman Construction

4702 Indian Creek Road

Macungie, PA 18062

Tel: 610-967-5677

E-Mail: [engelmanco@fast.net](mailto:engelmanco@fast.net)

**\*Bev Garnant**

American Society of Concrete Contractors

2025 S. Brentwood Blvd. Ste. 105

St. Louis, MO 63144

Tel: 314-962-0210

E-Mail: [bgarnant@asconline.org](mailto:bgarnant@asconline.org)

**\*Degan Hambacher**

FDG, Inc.

6850 W 52<sup>nd</sup> Avenue

Arvada, CO 80002

Tel: 303-940-9715

E-Mail: [degan.hambacher@fdgcolorado.com](mailto:degan.hambacher@fdgcolorado.com)

**Charles Hanskat**

Hanskat & Associates

9921 Carmel Mtn. Rd. #328

San Diego, CA 92129  
Tel: 858-538-7755  
E-Mail: [charles@hanskat.net](mailto:charles@hanskat.net)

**Brad D. Inman**  
P.O. Box 3458  
Ashland, OR 97520  
Tel: 541-487-8471  
E-mail: [braddinman@aol.com](mailto:braddinman@aol.com)

**Carl Janson**  
Hillsdale Fabricators/Alberici Constructors Inc.  
8800 Page Ave  
St. Louis, MO 63114-6106  
Tel: 314-733-2000  
E-Mail: [cjanson@alberici.com](mailto:cjanson@alberici.com)

**Rolfe Jennings**  
Concrete Reinforcing Steel Institute  
701 W. Main St.  
Waxahachie, TX 75165  
Tel: 972-937-6450  
E-Mail: [rolfe4crsi@msn.com](mailto:rolfe4crsi@msn.com)

**Tom Klemens**  
Hanley Wood, LLC  
426 South Westgate  
Addison, IL 60101  
Tel: 630-705-2611  
E-Mail: [tklemens@hanleywood.com](mailto:tklemens@hanleywood.com)

**\*Ward Malisch**  
American Concrete Institute  
38800 Country Club Drive  
Farmington Hills, MI 48331  
Tel: 248-848-3830  
E-Mail: [Ward.Malisch@concrete.org](mailto:Ward.Malisch@concrete.org)

**Calvin McCall**  
Concrete Engineering Specialists  
6222 Simpson Road.  
Charlotte, NC 28216  
Tel: 704-392-1506  
E-Mail: [wcmccall@concretees.com](mailto:wcmccall@concretees.com)

**Dave Meyer**

CECO Concrete Construction  
7400 Pagedale Industrail Court  
St. Louis, MO 63133  
Tel: 314-863-2326  
E-Mail: [davem@cecoconcrete.com](mailto:davem@cecoconcrete.com)

**Brian Miller**

National Precast Concrete Association, Inc.  
10333 N. Meridian St. Suite 272  
Indianapolis, IN 46290  
Tel: 317-582-2319  
E-Mail: [bmiller@precast.org](mailto:bmiller@precast.org)

**\*Larry Mrazek**

LGM Engineers, LLC.  
111 West Port Plaza Drive Ste. 600  
St. Louis, MO 63146  
Tel: 314-542-3178  
E-Mail: [lgmrazek@worldnet.att.net](mailto:lgmrazek@worldnet.att.net)

**\*Martin Murdoch**

M. E. Sabosik Associates  
2319 Bridge Avenue  
Point Pleasant, NJ 08742  
Tel: 732-892-2800  
E-Mail: [Martymurd@aol.com](mailto:Martymurd@aol.com)

**William Nash**

McCarthy Building Companies  
1341 North Rock Hill  
St. Louis, MO 63144-1498  
Tel: 314-968-3300  
E-Mail: [bnash@mccarthy.com](mailto:bnash@mccarthy.com)

**Theodore L. Neff**

Post-Tensioning Institute  
8601 N. Black Canyon Hwy. Suite 103  
Phoenix, AZ 85021  
Tel: 602-870-7540  
E-Mail: [teoneff@post-tensioning.org](mailto:teoneff@post-tensioning.org)

**Clyde Porter Jr.**

Clyde Porter Jr. Consulting Engineers  
405 Summit Ave  
Mt. Vernon, NY 10552  
Tel: 914-384-5920  
E-Mail: [clyde.porter@verizon.net](mailto:clyde.porter@verizon.net)

**D. Thomas Ruttura**

Ruttura & Sons Construction Company, Inc.  
165 Sherwood Avenue  
Farmingdale, NY 11735  
Tel: 631-454-0291  
E-Mail: [ruttura.ruttura@verizon.net](mailto:ruttura.ruttura@verizon.net)

**\*Mike Schneider**

Baker concrete Construction  
900 North Garver Road  
Monroe, OH 45050  
Tel: 513-539-4000  
E-Mail: [Mschneider@bakerconcrete.com](mailto:Mschneider@bakerconcrete.com)

**Lena Singer**

*Modern Steel Construction Magazine*  
One East Wacker Dr. Suite 3100  
Chicago, IL 60647  
Tel: 312-670-8316  
E-Mail: [singer@modernsteel.com](mailto:singer@modernsteel.com)

**Douglas Sordyl**

Strategic Development Council  
38800 Country Club Drive  
Farmington Hills, MI 48331  
Tel: 248-848-3755  
E-Mail: [Douglas.sordyl@concretesdc.org](mailto:Douglas.sordyl@concretesdc.org)

**\*Bruce Suprenant**

Concrete Engineering Specialists  
7720 Ferris Way  
Boulder, CO 80303  
Tel: 303-499-0264  
E-Mail: [suprenant@comcast.net](mailto:suprenant@comcast.net)

**\*Eldon Tipping**

Structural Services, Inc.

1300 East Lookout Drive Ste 320

Richardson, TX 75082

Tel: 214-522-6438

E-Mail: [etipping@ssiteam.com](mailto:etipping@ssiteam.com)

**\*Carl Wagus**

American Architectural Manufacturers Assn.

1827 Walden Office Square, Ste. 550

Schaumburg, IL 60173

Tel: 847-303-5664

E-Mail: [cwagus@aamanet.org](mailto:cwagus@aamanet.org)

\*Speaker