



# International Code Council

## ICC IS-3DACT Committee Agenda – Meeting #12

September 13, 2024 – 10:00 AM PT

### 1. Welcome and opening remarks

*Staff Co-Secretariat, Aileen Vandenberg called the meeting to order at 10:04 am PDT and welcomed all committee members, invited parties, and ICC staff. Ms. Vandenberg noted the committee must adhere to the ICC Code of Ethics, which states that those participating in ICC activity must adhere to the highest ethical conduct, with the purpose of the protection of the health, safety and welfare of the public by creating safe buildings and communities. In addition, Section 5.1.10 in Council Policy #7 is in effect and any committee member with a conflict of interest must withdraw from participating in discussion or vote on the matter in which they have an undisclosed interest. Lastly, Council Policy #50 outlines ICC Antitrust guidelines, which indicates the committee meetings are not intended for discussion of pricing and marketing topics.*

### 2. Quorum and Attendance

*Ms. Vandenberg called the roll of the IS-3DACT with the following members registering attendance. Ms. Vandenberg noted there was enough for a quorum.*

NAME	2024 IS-3DACT COMMITTEE MEETING					
	#9 6/7/24	#10 7/12/24	#11 8/9/2024	#12 9/13/24	#13 10/11/24	#14 TBD
Gabriel Carrera [D]	x	X	X	X		
Bora Gencturk [C]	x	X	X	X		
Rory Hamaoka [H]	x	-	-	-		
Werner Hellmer[H]	-	X	X	-		
Maryam Hojati [D]	x	X	X	-		
Berok Khoshnevis [D]	-	-	-	X		
Jeff Martin [A]	x	X	-	-		
Doug Mayer [H]	x	X	X	X		
Paul Messplay [H]	-	X	-	X		
Adil Tamimi [D]	x	X	-	X		
Bing Tian [A]	x	X	X	-		
David Langefeld [B]	x	X	X	X		
Eric Kreiger	-	-	X	X		
<b>TOTAL</b>	10/14	11/14	9/14	8/13		

*Interested parties in attendance included Abdul Peerzada (Quikcrete), Mahmut Ekenel (ACI), Muhammed Shakeel Akhtar (Parsons), Sean Monkman (ICON), Chris Kaufmann (Parsons)*

### 3. Approval of Agenda

*Chair Mr. Bora Gencturk asked for a motion of approval for the agenda. Mr. Gabriel Carrera motioned, and Mr. Paul Messplay seconded. The agenda was unanimously approved.*

#### 4. Approval of Previous Meeting Minutes

*Mr. Gencturk asked for a motion of approval for the previous meeting minutes. Mr. Carrera motioned, and Mr. Eric Kreiger seconded. The previous meeting minutes were unanimously approved.*

#### 5. Update on Structural Work Group (David Langefeld)

*Mr. Langefeld started the discussion on Chapter 4 by giving a brief overview of each section. Section 401 introduces the general design approaches as well as definitions. Section 402 covers the design criteria, loading and the limitations of the system for seismic loads. Section 403 gives minimum reinforcement and connection details. Section 404 provides guidance for engineering design provisions for material properties, reinforcement, section properties, and limit state calculations for different loads. Section 405 addresses connection details between the wall and floor and roof. Lastly, Section 406 specifies full-scale structural testing requirements.*

*Mr. Langefeld then presented three significant technical changes to Chapter 4. The first technical change was to add definitions such as webbing (Section 401.3.2.2 and Fig. 401.3.2.2). The second technical change was to include information on the fill material properties for cores, headers, and bond beams (Section 402.2.2). The third technical change was to provide guidance for reinforcement development (Section 404.12) for filled elements (Section 404.12.1) and printed beads (Section 404.12.2). Mr. Langefeld noted that this last section (reinforcement development for printed beads) was a topic of discussion for the committee.*

*Mr. Langefeld then started the discussion by addressing the outstanding comments in the chapter. The first comment on Section 401.8, Structural Analysis, was on the slenderness effects, wind, and second-order effects. The current section references Sections 6.6.4 or 11.8 of ACI 318-19. Mr. Langefeld explained the Structural working group was working on reviewing the ACI provisions and checking that there was no language that was hard to interpret and apply to a 3D printed wall system; if language was found, they would identify certain guidance or definitions that needed to be defined for analysis. Mr. Langefeld requested comments or advice on this topic. There were no comments.*

*Mr. Langefeld then moved on to the next comment, which was on Section 403.5 Minimum Connections Between Shells. He explained that the writing was unclear and needed to be re-written for better clarity. He suggested rewriting the paragraph as a prescriptive guidance that connects R-values, cavity widths and tie minimum requirements, for two or three climate zones based on the TMS provisions for cavity size and tie minimums and insulating R-values for different climate zones. The section would also include the option for a designer to do their own analysis of the connection between shells.*

*Mr. Langefeld continued to the next comment on Section 403.8 Minimum Core Fill Dimensions. Mr. Langefeld explained that since Chapter 4 focused on structures, the section stopped short at providing guidance for the required inspection, testing and quality assurance programs needed for the core filling material during construction. He suggested to included language directing the designer to give guidance in the construction documents or elsewhere about the core filling in Chapter 1.*

*The next comment was on Section 403.14.2 Print Stops. Mr. Langefeld pointed out that the document after public comment will need to be coordinated throughout the various chapters. For*

example, the items in Chapter 5 that are required to be reported for submittal need to be in line with the same items referenced in Chapter 4.

The next comment was on Section 404.2.1.2 Compressive Strength. Mr. Langefeld pointed out that Mr. Carrera voted negatively on this topic in Chapter 3. He requested input from the committee on how to correlate between what a designer requires for 28-day compressive strength to what the field prequalification strength results are, either from cubes sawn from a printed sample or cylinders, and whether it's an average of those breaks or equivalent to an  $f_{cr}$  value. Mr. Langefeld did not think this information was appropriate to put into Chapter 4 but stated it needed to be in the document somewhere. Mr. Gencturk suggested to Mr. Langefeld to put at the end of Chapter 4 any items that the Structures working group thought needed to be addressed in the document but did not belong in Chapter 4. These items could still be voted on with Chapter 4. Once the items went through a technical vote and were approved, they could be moved to another Chapter in the document. Mr. Langefeld agreed with this but commented that input from the Materials work group was needed. Mr. Langefeld stated he would coordinate with Mr. Bing Tian regarding this collaboration.

Mr. Langefeld continued to Section 404.3.1 Effective Structural Contact Width. He explained the difference between the effective structural contact width and the nominal bead width and how this section provided a calculation method for the effective structural contact width from the nominal bead width. However, he pointed out that in Chapter 5 the effective structural contact width can be measured during the field prequalification. Mr. Langefeld asked the committee which approach they favored - a structural engineer specifying a nominal bead width and an effective structural contact width that then a producer must meet in the field or a structural engineer designing for an existing 3D printed system where those parameters are known and verified in the field prequalification. Mr. Langefeld offered his point of view first, in which he preferred the second option. He gave two examples to explain his view - CMU design, where CMU blocks with known nominal dimensions are used for the design and bridge girders, where set girder shapes and depths are used for the design. Mr. Langefeld suggested to provide preliminary design guidance for when the system is not known yet, followed by the requirement that the final design be to the specific system once known. Mr. Eric Kreiger suggested having both options available. Mr. Carrera agreed with Mr. Kreiger that having both would be beneficial. Mr. Langefeld asked if a structural designer had to guess the nominal bead width when there was no known system. Mr. Kreiger confirmed that an engineer would have to guess if this information was not known. Mr. Jared Brewé offered an example of an engineer designing a wall to a certain thickness. The producer printing the wall would have to determine whether they could achieve that thickness with a single bead or multi-bead path. Mr. Chris Kauffman wrote in the chat to assume the nominal bead width and then require field qualification. Mr. Langefeld commented that this route could be detrimental to the economy of the project. He said that changing the geometry of the bead was not necessarily a simple task given all the hardware considerations that go into it. Mr. Doug Mayer commented that there were two approaches that could be taken - one where there was a close collaboration with the manufacturer and designer up front or one where the designer initiates projects, forcing manufacturers to publish information about their bead geometries so that designers have access to that information. He said that whatever path taken in this standard will push the industry in that direction. Mr. Langefeld said he was not considering these approaches. He was thinking that the prequalification was something that manufacturers would do regularly like what Hilti or Simpson Strong-Tie do with anchors. If a manufacturer had published data, then a designer could go to a design system that was determined by testing. Mr. Carrera commented that having a manual of systems would suffice. Mr. Langefeld suggested to reword the text of the Section 404.3.1.1 from Preliminary Design to Design in the

September 13, 2024

absence of test data and Section 404.3.1.2 from Final Design Determined by Testing to Design through Test Data. There were no objections to this re-wording.

The next comment was on Section 404.3.2 Effective Side Face Contact. Mr. Langefeld explained that this section was added to address the effective side face contact, which occurs when there is print path overlap between beads, with the amount of contact determined by the degree of overlap. If a designer did not have information about the effective side face contact, then the most conservative assumption would be to assume there was no print path overlap. The intent of this section was to provide guidance for a designer to specify in the contract documents when print overlap was needed without specifying an exact amount of overlap, since this value is dependent on varying hardware and so forth. Mr. Langefeld suggested making a subtle revision to Chapter 5 which would require beads to be touching. Mr. Carrera and Mr. Kreiger agreed with this approach.

Mr. Langefeld continued to the next comment on Section 404.4.2.5 Reinforced Flexural Capacity. He suggested adding in the requirement, which comes from TMS, that the reinforcement capacity,  $\phi_{Mn}$ , must be at least 1.3X the cracking moment  $M_{cr}$ . Mr. Carrera, Mr. Mayer, and Mr. Kreiger were tentatively in agreement with this suggestion, but agreed that more thought would need to be given to it.

The next comment was on Section 404.11 Strength Reduction Factors. Mr. Langefeld asked if there were any comments on the chosen 3D phi factors for Table 404.11. Mr. Carrera asked about the explanation for making the 3D phi factors for the flexure, shear and bearing the same. Mr. Langefeld responded that because concrete is a known material the Structures working group felt that only a 5% reduction was needed. The 3D factor for axial was reduced by 20% because of the interaction between the core and the shell could result in a brittle failure. Mr. Kreiger was in general agreement with the Axial, Shear, and Bearing 3D reduction factors, but suggested more thought be given to the Flexural reduction factor. He said in his experience there were instances where the reduction factor was different for out-of-plane walls due to the distribution of cracking at interfaces. He found there was some reduction in strength but more so in ductility.

Mr. Langefeld continued to Section 404.12 Reinforcement Development. For Section 404.12.1, which addressed cores, headers, and bond beams that are filled with 3D printed materials, Mr. Langefeld asked the committee of their opinion about taking the development length equations from TMS as he explained that the 3D printed material was not much different than the grout for masonry. Mr. Kreiger commented that he agreed with this assumption. For Section 404.12.2, which addressed the development length in printed beads, Mr. Kreiger commented that there was not a lot of understanding about the development length within printed elements and thus assuming that this equation was valid was kind of hard to say. Mr. Mayer agreed. Mr. Langefeld explained that the formula was a 25% increase from before and the bar size was limited to 40% of the effective contact width. He commented that he thought the bar size should go into the detailing chapter. Mr. Carrera asked if the 25% increase was based on research. Mr. Langefeld said there was very little research and the research that did exist was conflicting. Thus, 25% was chosen as a starting point with the caveat that it will be adjusted as more research comes in. Mr. Langefeld pointed out that there were limitations in place in previous chapter sections that determined when to consider a shell reinforced and unreinforced based on the structural depth. Mr. Carrera was satisfied with Mr. Langefeld's response. Mr. Kreiger added that he didn't see an issue with the wire in the beads but questioned the bar diameter limit of 40% of the effective contact width. He suggested making it 20%, citing an example that in a 2-in bead this would be a 3/8-in bar. Mr. Carrera asked if the 40% was based off the splice location. Mr. Langefeld confirmed that it was and suggested having

multiple limits – one for single beads, another for splices. Mr. Carrera asked about the possibility of having non-contact splices. Mr. Kreiger asked if anyone had any experience of placing a splice in a single bead. Mr. Langefeld commented that a previous section only allows simply supported shells between two cores, and asked whether splices were needed. Mr. Langefeld suggested 25% and tagged it as a topic for discussion for the next Structural working group meeting.

Continuing to Section 405.2 Design Requirements, Mr. Langefeld gave a quick overview of the section - post-installed anchors were reliant on the fill material only. The contribution of the shell would be ignored. There were no comments on this section.

Finally, Mr. Langefeld summarized Section 406 Alternative Structural Design and Testing Provision. It was essentially AC509 where design methodologies were substantiated through full scale testing with additional sections added on for alternative testing methods. He noted that the Structural working group realized that there were a lot of opportunities for small scale testing that could help refine some of the engineering design. Therefore, Section 406.5 allows for a testing party to prove their alternative testing method is equal or better in performance than what was being specified as the minimum requirements in the standard.

#### 6. Additional Discussion of Initial Draft

Mr. Gencturk reiterated that the next meeting will be to vote on the material in Chapter 4. Then whatever technical material that does not belong in this chapter can be moved to another chapter. Mr. Langefeld asked about voting on Chapter 1 and Chapter 2. Mr. Gencturk replied that Chapter 2 is mostly definitions and does not necessarily need to be voted on. For Chapter 1, voting can be during the same voting session of Chapter 4.

#### 7. Next Meeting

The next meeting is set for October 11, 2024, at 10am Pacific Time.

#### 8. New Business

There was no new business.

#### 9. Action Items & Summary

The action items from the meeting were summarized as follows:

Structures working group to meet on September 19, 2024.	Mr. Langefeld
Circulate Chapters 1 and 4 to the entire committee by October 1, 2024.	Ms. Vandenberg / Ms. Sanchez and Mr. Langefeld, respectively.

With no other questions or comments before the committee Mr. Gencturk moved to adjourn the meeting. Mr. Mayer motioned for adjourning and Mr. Carrera seconded. The meeting adjourned at 11:36pm Pacific Time.