



International Code Council

ICC IS-3DACT Committee Agenda – Meeting #13

October 11, 2024 – 10:00 AM PT

1. Welcome and opening remarks

Staff Co-Secretariat, Aileen Vandenberg called the meeting to order at 10:03 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					
	#10 7/12/24	#11 8/9/2024	#12 9/13/24	#13 10/11/24	#14 1/10/25	#15 TBD
Gabriel Carrera [D]	X	X	X	x		
Bora Gencturk [C]	X	X	X	x		
Rory Hamaoka [H]	-	-	-	x		
Werner Hellmer[H]	X	X	-	x		
Maryam Hojati [D]	X	X	-	x		
Berok Khoshnevis [D]	-	-	X	-		
Doug Mayer [H]	X	X	X	x		
Paul Messplay [H]	X	-	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	x		
TOTAL	11/14	9/14	8/13	11/12		

Interested parties in attendance included Abdul Peerzada (Quikcrete), Robert Devine (WJE), Stephan Mansour (ASTM), Muhammed Shakeel Akhtar (Parsons), Chris Kaufmann (Parsons)

3. Approval of Agenda

Chair Mr. Bora Gencturk asked for a motion of approval for the agenda. Mr. Adil Tamimi motioned, and Mr. Werner Hellmer 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. Doug Mayer motioned, and Mr. Eric Kreiger seconded. The previous meeting minutes were unanimously approved.

5. Update on Structural Work Group (David Langefeld)

Mr. David Langefeld gave brief overview of the completion of Chapter 4. He explained there were two subcommittee work group meetings that worked on the remaining comments and topic areas of Chapter 4. However, a few comments and coordination items were left open for today's discussion.

6. Committee Vote – Chapter 4 – Structural Design

Note: The discussion on Item 6 – Chapter 4 happened after the discussion on Item 7 – Chapter 1.

Mr. Gencturk first started the discussion on Chapter 4 with the outstanding comments. The first comment was on Section 403.8 about core filling. Mr. Langefeld said this could be lumped in with the table in Chapter 1 with Special Inspections. The next coordination item on required inspection/testing/quality was withdrawn by Mr. Langefeld as it was already addressed. In Section 403.14.2 the coordination item was to ensure that print stop interlayer protocols were coordinated in Chapter 5. Upon inspection of Section 501.7(h), they were already added and thus the comment was withdrawn. Mr. Carrera noted that print stop interlayer protocols should also be added to the construction documents in Section 108.

For Section 404.2.1, the coordination item was to ensure Chapter 5 included specified ranges for slump, air, etc. in the construction documents. This comment was withdrawn as the submittal documents in Chapter 5 already included them. For Section 404.2.1.2, the coordination item stated the standard needed to include language on how design material strengths were confirmed. Mr. Devine said he didn't believe this comment had been addressed since the standard doesn't specify how to get f'_{cr} . He elaborated by explaining that ACI 301 requires testing and statistics on the compressive strength to demonstrate that a concrete mixture would have only a 1 in 100 failure rate, and thus, this comment was to address how Section 501 or Chapter 3 are interpreted. He added that Section 502 was intended to wave a "red flag" when the mix doesn't meet expectation.

Mr. Gencturk said this was a good point of discussion, but in the interest of time, moved to the next coordination item in Section 404.2.2 which was on specifying the infill material's slump, air content, etc. in the construction documents. Mr. Gencturk pointed out that Section 108 already referred to the IBC for other requirements and the infill material would be covered under this. Mr. Langefeld agreed and withdrew the comment. The next coordination item was in Section 404.3.1.1 on listing the nominal bead width and effective structural contact width in the contract documents. Mr. Gencturk suggested adding this to Chapter 1. Mr. Langefeld said it depended on how the widths were determined, either through Chapter 4 or by measuring. He asked if the standard should include a requirement that the method of obtaining these widths should be specified. Mr. Carrera said that it was already specified to provide the general wall cross-section and dimension and thus this would be inherent to that. Mr. Langefeld agreed and withdrew this comment.

For Section 404.5.4 Mr. Gencturk had a question of whether to use "can" or "shall". Mr. Langefeld said "can" because the combined moment and axial load doesn't always occur. He suggested to remove the word "can" altogether and just word it as "which accompanies".

Since there were no further comments to address, Mr. Gencturk returned to the comment in Section 404.2.1.2. He suggested this could be included in Chapter 3 or Section 501. Mr. Langefeld

commented that a direct translation of ACI 301 would not work here but felt that it belonged in Section 501. However, he said that this was something that should be tabled until after the public commenting period. Mr. Tian agreed. Mr. Langefeld envisioned compressive strength to be determined from sawn cubes with the challenge being the sample size. The approach would be more ACI 562 rather than ACI 301. Recognizing more discussion was needed Mr. Gencturk agreed to table it for later. Mr. Devine commented that putting in Section 501 a statement that requires compressive strength tests to be evaluated per an appropriate statistical method to determine appropriate specified design strength would show that the committee had thought about this issue. Mr. Gencturk agreed and included a statement in Section 501.6.2.1.

7. Committee Vote – Chapter 1 – Application and Administration

Mr. Gencturk started the discussion by giving an overview of Chapter 1 and then opened the floor for discussion. Mr. Langefeld asked if the general population understood what 3D concrete printing technology was. If not, he suggested putting in a paragraph that described what the technology was and how it differed to cast-in-place technology. Mr. Gencturk countered that this document was a standard and not a guide document. Mr. Kreiger clarified that the engineer using this document would already have a basic understanding of the 3D technology. Mr. Gencturk confirmed that this was correct.

Mr. Adil Tamimi commented the phrase 3D printing material was too general as the scope of this standard only considers concrete or mortar. Mr. Gencturk said that the definition of 3D printing material was in Chapter 2, and it specifies that in this standard 3D printing material means either concrete or mortar.

Mr. Langefeld commented that Chapter 1 was silent in what was needed to be included in the construction documents for 3D printing. He wondered if a section was needed for construction document specifications. Mr. Gencturk replied that there was a section in Chapter 5 (Section 501.7) for this and thought that Chapter 1 was not the correct place for this. Mr. Langefeld countered that Chapter 5 does not address everything such as nominal bead width, effective contact width, the printed material, and the infill material. He also commented that there was a subtle difference between the submittal requirements in Section 501.7 and construction documents. He said submittal requirements are when a producer performs what is in Section 501.7 and creates tables or design guides that designers can rely upon. Construction documents are when a designer is operating independently, and the producer must verify and match what the designer has assumed. Mr. Gencturk suggested adding a section to Chapter 1, Section 108 – Minimum Information Required in Construction Documents. The committee came to a consensus to add a general description of the 3D printing system used, specifically including the nozzle dimensions, the design method utilized either in conformance with Section 404 or Section 406 of this standard, the weight of the structure considered, nominal bead dimensions (width and height), an indication of whether non-dimensionally or dimensionally controlled extrusion, material design strengths and reporting age for cementitious materials, and maximum aggregate size used in 3D printing materials. All other requirements from IBC shall still apply.

Mr. Gencturk asked if there were any more comments on Chapter 1. Mr. Langefeld commented the mention of flexural bond strength in Section 105 Special Inspections is not correlated with Chapter 5, which only mentions compressive strength. Mr. Gencturk deleted reference to flexural bond strength. Mr. Gabriel Carrera asked if Section 1704 of the IBC, which references

special inspections for masonry should be included. The committee could not determine if this should be included with “and” or “or” or not at all. Mr. Langefeld suggested creating a table specific for 3D printing as neither 1705 nor 1704 completely apply to 3D printing. Mr. Robert Devine agreed with this idea. Mr. Gencturk commented that this could be a discussion point for after the public commenting period.

Mr. Gencturk asked if there were any more comments on this section. Mr. Langefeld said the statement “90% of the minimum compressive strength” was confusing. Mr. Devine asked if this provision was trying to ensure that there wouldn’t be too much reduction during the printing process or if it was trying to do the same thing as Section 26.12.3 of ACI 318 where general quality control was the purpose. Mr. Kreiger could not recall where he mentioned 90% before, but said the intent of this statement was to specify that the specimen tests in the field meet or exceed the design strengths and the prequalification strengths. Whether testing was based on the cast strengths or the printed strengths was up to the designer.

Mr. Devine then asked a general question regarding whether having acceptance criteria, like ACI 318, for test specimens was needed somewhere in this document. Mr. Bing Tian agreed that there needs to be a section in Chapter 5 to interpret the results. He further said the sentence about the 90% should be taken out of Chapter 1. Mr. Langefeld interpreted that Section 501 was to establish a relationship between the cast and print samples and 502 was meant to confirm that the design strength specified by the designer in the construction documents was being achieved. Mr. Devine agreed. Mr. Kreiger said that 502 should be compared to 501 and Chapter 4 in terms of what the designer comes up with. Mr. Gencturk disagreed and said the comparison should be against Chapter 3. Mr. Langefeld countered Chapter 4 specifies what the designer wants, not Chapter 3. He gave the example of how a laboratory mix could have a maximum compressive strength of 6000 psi, but if the designer needed only 4000 psi, then the needs of the designer would govern the criteria. Mr. Devine said there needed to be some criteria to determine f'_{cr} . He suggested defining how to determine f'_{cr} in Chapter 3. Mr. Langefeld suggested f'_{cr} should be based off Section 501 because the material has been run through a printer. Mr. Devine agreed, but pointed out he was coming from the ready-mix industry whereby f'_{cr} was initially developed in the lab, but revised as field data was collected. He reiterated that there needed to be some guidance how to determine f'_{cr} .

In the interest of time Mr. Gencturk paused the conversation to ask what acceptance criteria should be placed in Section 502. Starting with Section 502.2 on workability, Mr. Gencturk suggested to add “as determined in Section 501.6.1.1 of this standard”. Mr. Tian said for workability and air content that acceptance criteria were not needed. Mr. Gencturk explained that this was referencing the acceptance criteria that were already in 501. Mr. Langefeld mentioned Section 501.7(d) for workability and air content needed to be referenced too.

Moving on to Section 502.4, Mr. Gencturk asked if the acceptance criteria for the compressive strength for the walls and from the nozzle should be the same. Mr. Tian replied they should be the same. Mr. Tian asked the question again where the 90% came from. Mr. Devine shared in the chat Section 26.12.3 of ACI 318 that indicates the strength level of a concrete mixture is acceptable if no strength test falls below f'_c by more than 500 psi if f'_c is 5000 psi or less; or by no more than $0.10f'_c$ if f'_c exceeds 5000 psi. Mr. Gencturk said the 90% comes from this and it was the more conservative option. Mr. Tian agreed.

Mr. Gencturk then suggested the acceptance criteria should be in accordance with the construction documents and Section 501.6.2.1 because a producer could meet or exceed the strength requirements of the construction documents, but not the mixture, indicating something was wrong with the mixture. Mr. Devine said this was a deviation from what ACI 318 specified. Mr. Langefeld said a ready-mix provider was not going to compare their cylinders to the structural drawings and to the f'_{cr} of the submittal. Mr. Gencturk agreed but countered with the example of a designer requiring a f'_{cr} of 3000 psi, but the company selects a 6000 psi mixture, and when they test it in the field they get 2700 psi. While this was within 10% of the design f'_{cr} , it was far off from the intended strength. He asked if this was acceptable. Mr. Langefeld said yes because f'_{cr} was based off a population of specimens and there were always going to be outliers. Thus, he stated that the compressive strength should not be compared to field testing. Mr. Kreiger asked if the intent was to compare both the field prequalification compressive test in Section 501 and the Acceptance Test in Section 502 to the design strength or if it was to compare the field prequalification test in Section 501 to the design strength and the Acceptance Test in Section 502 to the field prequalification test in Section 501. He suggested that it was more the former, that the Acceptance Test in Section 502 would be compared to the specified design strength from Chapter 4. Mr. Tian agreed. He said that the field prequalification testing was part of the quality control/assurance of a project. Mr. Gencturk asked what the point of the field prequalification testing was. Mr. Langefeld said that field prequalification was to demonstrate that the material in a printer as a system meets the structural parameters and suggested that it should have a statistical buffer. Once in a project the criteria to meet would be the design strength and not the f'_{cr} . Mr. Devine said it was to demonstrate that they have the compressive strength specified in Chapter 4. Mr. Gencturk asked where in the document did it say Section 501 was required. Mr. Langefeld countered that it wasn't explicitly said 501 was optional and thus it is inferred that it is required. He said Chapter 4 explicitly gives the options.

In the interest of time, Mr. Gencturk said he will leave the issue of specifying whether Section 501 was required to after the public commenting period. After some more discussion, the final criteria was revised to read, "Compressive strength determined in this section shall be such that a) Every average of any consecutive three compressive strength tests equals or exceeds the specified design strength used in Chapter 4 of this standard and, b) No strength tests falls below 90% of the specified design strength used in Chapter 4 of this standard".

The discussion then moved to Item 6 – Chapter 4, before returning to a motion to vote for the entire document.

Mr. Gencturk asked for a motion to vote to move the standard to public comment. Mr. Langefeld motioned to vote, and Mr. Tian seconded the motion.

The committee voted 11/12 to approve the standard draft. Mr. Berok Khoshnevis was absent to vote.

8. Next Meeting

The next meeting will be January 10, 2025, at 10am PST.

9. New Items

Items to discuss after the public comment period:

- a) *Section 105 Special Inspection – Should special inspection procedures for masonry be included?*
- b) *Section 403.8 Comment – Coordination Item: Elsewhere in standard provide information about core filling and cleanouts. Items to consider in another chapter: min. curing times before filling, minimum slump of fill material, whether mechanical vibration is required. Suggest: Section 105 Special Inspection.*
- c) *Section 404.2.1.2 Comment – Coordination Item: Include language on how design material strengths are confirmed.*
- d) *Negative vote from Mr. Carrera on Chapter 3. How are the results in Chapter 3 interpreted in terms of design? In cast-in-place concrete, there is a certain amount of overstrength of the ready-mix concrete so that the hardened concrete properties of the in-place material meet and exceeds the design strength. Are we going to assume a design strength based off these test results that is some percentage lower to account for variability of in-place material properties. Discussion needs to be had on what kind of statistics or phi-factor is needed.*
- e) *Section 501.6.2.2 about adding a minimum flexural bond strength criterion.*
- f) *Specifying Section 501 is required.*

10. Action Items & Summary

The action items from the meeting were summarized as follows:

<i>Post the draft for public input by mid-November.</i>	<i>Ms. Vandenberg / Ms. Sanchez</i>
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With no other questions or comments before the committee Mr. Gencturk moved to adjourn the meeting. Mr. Langefeld motioned for adjourning and Mr. Hellmer seconded. The meeting adjourned at 12:02pm Pacific Time.