International Code Council

ICC IS-3DACT Committee Minutes – Meeting #8

May 10, 2024 – 10:00 AM PDT

1. Welcome and opening remarks

Staff Secretariat, Melissa Sanchez called the meeting to order at 10:02 am PDT and welcomed all committee members, invited parties, and ICC staff. Ms. Sanchez announced that David Langefeld from ICON will vote in place of Ms. Aubrey Smading until his appointment is confirmed by the board.

Ms. Sanchez then went on to note 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. Sanchez called the roll of the IS-3DACT with the following members registering attendance. Ms. Sanchez noted there was enough for a quorum.

	2024 IS-3DACT COMMITTEE MEETING						
NAME	**#3 12/15/23**	**#4 1/12/24**	**#5 2/9/24**	**#6 3/15/24**	**#7 4/19/24**	**#8 5/10/24**	**#9 6/7/24**
Jared Brewe [A]	X	X	-	X	X	X	
Gabriel Carrera [D]	X	-	X	X	X	X	
Bora Gencturk [C]	X	X	X	X	X	X	
Rory Hamaoka [H]		X	X	X	-	X	
Werner Hellmer[H]	X	-	X	X	X	X	
Maryam Hojati [D]		-	X	X	X	-	
Berok Khoshnevis [D]	X	X	-	-	X	X	
Jeff Martin [A]	X	X	-	X	X	-	
Doug Mayer [H]	X	X	X	-	X	X	
Paul Messplay [H]	X	-	X	X	X	X	
Adil Tamimi [D]		X	-	X	X	X	
Bing Tian [A]	X	X	X	X	X	X	
David Langefeld [B]						X	
TOTAL	10/13	9/13	8/12	10/12	11/12	11/13	

Interested parties in attendance included Abdul Peerzada (Quikcrete), Daniel Galvez Moreno (ICON), Don Ajamian (Emergent 3D), Robert Devine (Wiss, Janney, Elstner Associates), Christopher Kaufmann (Parsons), Stephan Mansour (ASTM), Sean Monkman (ICON), Gene McConkey (City of Athens, Tennessee Building Official), Mahmut Ekenel (ACI), Zanini Mariano (University of Padova)

3. Approval of Agenda

Chair Mr. Bora Gencturk asked if there was any opposition to the agenda. There were no objections. The agenda was unanimously approved.

4. Approval of Previous Meeting Minutes

Mr. Gencturk asked if there was any opposition to the previous meeting minutes. There were no objections. The previous meeting minutes were unanimously approved.

5. Update on Work Groups
    a. Materials Work Group (Bing Tian)
    Mr. Bing Tian stated that the Materials Work Group finished Chapter 3 and submitted it to the full committee for comments and balloting for today. He also mentioned a separate meeting was held to address the need for a mock-up wall requirement.

    b. Structural Work Group (Jared Brewe)
    Mr. Jared Brewe shared they are waiting to see how the committee feels about Chapter 3 to have a good sense of direction to finalize the structural provisions in Chapter 4.

6. Committee Vote – Chapter 3 – 3D Printing Material Laboratory Prequalification – Testing Methods and Performance Requirements

    Mr. Gencturk started the discussion with the title of Chapter 3. He emphasized that 3D Printing Materials means either 3D Concrete or 3D Mortar.

    He then proceeded to Section 301.1 - Material mixture constituents. Mr. David Langefeld commented that ASTM C1157 should be added to the section for cement requirements. Mr. Tian agreed. Mr. Gencturk added this into the section. Mr. Tian commented that ASTM C144 and ASTM C330 should be added for the aggregate requirements. Mr. Werner Hellmer asked whether lightweight aggregates compounded the structural requirements in Chapter 4. Mr. Langefeld asked whether the requirements on gradation should be more lenient, allowing a supplier to use a gradation outside of the standards. Mr. Tian replied that the this was not a good idea from a safety point. He said there is more to the standards than gradation, there are purity, debris, and organic content requirements. Mr. Daniel Galvez Moreno agreed with Mr. Langefeld. He said that using aggregates complying to the standards may not result in the best printable material. Mr. Gencturk agreed with Mr. Tian. He said the gradation and other properties of the aggregates are tied together. Mr. Tian stated that it is too liberal approach to go beyond the standards. Mr. Adil Tamimi agreed with Mr. Gencturk and Mr. Tian. Mr. Abdul Peerzada stated that different gradation can be achieved through blending while still being code compliant.

    Mr. Mahmut Ekenel questioned the validity of adding ASTM C330. He said the lightweight factor, also known as the lambda factor from ACI 318, was calibrated for normal weight concrete and not for 3D printed concrete. Mr. Brewe agreed with Mr. Ekenel that they don't have the relevant information for lightweight aggregates to include in the structural provisions. Mr. Gencturk removed ASTM C330 from the section.

Mr. Brewe commented that ASTM C1017 has been withdrawn with no replacement and has been removed from ACI 318. Mr. Gencturk removed the standard from the section as there is no replacement for this standard.

Moving on to Section 301.2 – Testing submittal, Mr. Gencturk removed the terms laboratory and institution and replaced it with agency.

For Section 301.3 – Material mixing and curing, Mr. Langefeld commented that mixture design is a typo. Mr. Gencturk removed it from the section. Mr. Gencturk also changed the term water demand to water content. Mr. Tamimi agreed with this language change.

Mr. Gencturk made minor edits for Section 301.3.1 and Sections 302.1, 302.2, 302.3, and 302.4. For Section 302.5 Mr. Gencturk asked why set time was still optional. Mr. Galvez Moreno responded that the test is meaningful for some producers but not for others. He suggested to get rid of the requirement. Mr. Tian disagreed and suggested it should be required. Mr. Ekenel suggested to add a statement when a specified set time is required by an agency. Mr. Gencturk agreed to this suggestion and added the phrase "when a specific set time is required for material performance."

The next section with comments was Section 303.3 – Shrinkage. Mr. Peerzada asked whether a statement about how the specimen is cured, either in water or air, be added since ASTM C157 has both. Mr. Robert Devine commented that in ASTM C928 for cementitious repair mortars requires +0.15% max increase after 28 days in water and -0.15% after 28 days in air. Mr. Peerzada added that according to ASTM C928, those values correlate with 28 days of water curing followed by either 28 days of air drying or water curing for those values. Mr. Gencturk commented that ASTM C928 is not mentioned in this section and asked what ASTM C157 states. Mr. Tian said that ASTM C157 specifies several days to check length. Mr. Gencturk concluded that adding the phrase "28 days of air storage" before measuring length change will address this.

Mr. Ekenel asked why there were two different shrinkage lengths for mortar and concrete and how this relates to structural design. Mr. Gencturk agreed that this questioning was valid as the two materials might crack differently. Mr. Brewe said the biggest change would be in the modulus of elasticity, which affects the minimum reinforcement requirements. Mr. Gencturk agreed that reinforcement requirements for mortar would be larger than concrete. Mr. Behrokh Khoshnevis asked why there needed to be two values. It would make sense to make the mortar or concrete to act like the other. Mr. Gencturk thought this was a good question. Mr. Tian agreed that concrete could be made to match the mortar shrinkage requirements. Mr. Ekenel commented that it is better to go conservative and offered a value of 0.065% which comes from repair mortar specifications. He acknowledged that it is expensive for the mortar producers, but this value can be reached with shrinkage admixtures. Mr. Tian and Mr. Gencturk disagreed with this value citing that it was very expensive for mortar producers and that this material is more relaxed than repair mortar. Mr. Brewe commented that the minimum amount of reinforcement requirements will increase for larger values like 0.15% and thus it is a balance between the cost of the mortar and the reinforcement. Mr. Devine mentioned that per ACI 223-21, concrete drying shrinkage ranges from 0.03% to 0.11% and that 0.15% would be too relaxed compared to typical concrete and may require special reconsideration for minimum reinforcement according to ACI. Mr.

Gencturk then proposed to settle for 0.10% for both the concrete and mortar and to take out the fiber-reinforced materials language.

Mr. Gencturk then called for a three minute break.

After the break, the discussion turned to section 303.4 – Flexural strength of 3D printing material with fibers. Mr. Gabriel Carrera commented that tensile strength affects the structural performance of the structure made with the proposed design methodology and asked why only the fiber-reinforced material was to be tested. Mr. Devine agreed with this comment. Mr. Gencturk asked when tensile strength of concrete is used, and if the section was necessary. Mr. Brewe responded that it could be applicable when designing plain concrete elements. Mr. Ekenel commented that the title of the section should be changed to toughness since the measurement ASTM C1609 measures is toughness. Mr. Gencturk asked when is the test would be needed. Mr. Ekenel responded that for material performance it is used to compare different fibers, but for the intent the section was written it might not be needed. Mr. Christopher Kaufmann and Mr. Gencturk agreed with this. Mr. Gencturk then deleted this section.

Mr. Carrera asked a general question about Section 303 and why there wasn't any testing on printed concrete in the lab. Mr. Gencturk replied that that will be addressed in Chapter 5 which is on field testing.

For section 303.5 – Interior wall finish test, Mr. Hellmer asked if this needs to be included. Mr. Gencturk stated that it was material specific. Mr. Ekenel mentioned it was a fire issue for the fibers and was good to keep in because it is required in the IBC. Mr. Brewe mentioned that word "shell" should be omitted as it was a term used in Chapter 4. Mr. Gencturk agreed and removed this word.

For section 304.1 – Freezing and thawing resistance, Mr. Gencturk brought up the phrase 'all specimens' is not needed because that is what the definition of average assumes 'all specimens' are averaged. Mr. Brewe brought up that ASTM C666 has been withdrawn. Mr. Peerzada mentioned that it is in the process of being revalidated. Mr. Brewe asked which method, A or B, should be mentioned. Mr. Ekenel stated Method A with 300 cycles and a durability factor of 80% was the method in AC509. Mr. Peerzada stated that a lot of labs can do Method A, but preferred Method B. Mr. Devine mentioned that Method B was the better method as it was more representative of what the 3D printed walls would be subjected to. Mr. Ekenel stated that these methods were different and thus should have different durability factors. Mr. Gencturk commented that the challenge for labs is not Method A or B, but the measuring of the durability factor as many labs do not have the equipment for this. Mr. Ekenel mentioned that there was an Acceptance Criteria on Composite, Ultra-High Performance Concrete (UHPC) Panel Systems (AC493) that mentioned the durability factor for Method B shall be a minimum of 90% after 300 cycles (4.2.3.2 and 4.2.3.3 of AC493). Mr. Gencturk commented that this was for UHPC and thus very strict. He then requested that Mr. Peerzada look into Method B data and find how many cycles and the durability factor for it. Without enough supporting data for Method B, Mr. Gencturk added that Method A should be utilized with ASTM C666.

For the final section, 304.3 – Chloride content requirements, Mr. Peerzada commented that it should be ingress instead of content. Mr. Gencturk suggested permeability. Mr. Gencturk asked about the requirements for the environmental conditions. Mr. Brewe said that the sea

exposure categories have been revised to consider air borne chloride when near a saltwater body. Mr. Gencturk stated that the allowable diffusion coefficient cannot be determined from this. Mr. Peerzada suggested to defer to ACI if there is a chance of exposure to chlorides. Mr. Gencturk agreed with this. Mr. Devine referenced Section 19.3 of ACI 318-19 for the exposure categories. Mr. Ekenel stated that specifically it was Table 19.3.2.1. Mr. Peerzada suggested also to remove the phrase "in regions where freeze-thaw is required".

In the interest of time, Mr. Gencturk moved the discussion to the voting. Ms. Sanchez reminded everyone that the document will be open to public comments.

Mr. Gencturk called for a motion of approval for Chapter 3. Mr. Hellmer motioned and Mr. Tian seconded the motion. Mr. Gencturk asked if there were any objections. Mr. Carrera objected. The motion was approved with one negative vote.

7. Additional Discussion of Initial Draft

   There was no additional discussion of the draft outside of Chapter 3.

8. Next Meeting

   The next meeting is set for June 7, 2024, at 10am PDT.

9. New Business

   Ms. Sanchez announced that talks between ACI and ICC were taking place for a collaboration between the two respective 3D concrete printing committees.

10. Action Items & Summary

    The action items from the meeting were summarized as follows:

Send comments by email for negative vote.	*Mr. Carrera*

With no other questions or comments before the committee Mr. Gencturk moved to adjourn the meeting. Mr. Brewe motioned for adjourning and Mr. Langefeld seconded the motion. The meeting adjourned at 12:10 pm PDT.