ACI-ASCC Survey on Portland-Limestone Cement Concrete

Summary of responses and comments

by James Klinger, Kevin A. MacDonald, Jerry A. Holland, Scott M. Tarr, Beverly A. Garnant, and Bruce A. Suprenant

The transition from Type I portland cement (also referred to as ordinary portland cement [OPC]) to Type IL portland cement (also known as portland-limestone cement [PLC]) is well underway. The change has prompted many discussions among industry professionals in the United States. Unsurprisingly, the topic has been raised in many committee meetings at ACI Concrete Conventions.

At the Spring 2022 convention in San Francisco, CA, USA, Kevin MacDonald, Chair of ACI Committee 302, Construction of Concrete Floors, proposed a survey to gather information on contractors' experiences with PLC concrete. Beverly Garnant, Executive Director of the American Society of Concrete Contractors (ASCC) at the time, volunteered ASCC's assistance in the development and evaluation of the survey; and we, the co-authors of this article, served on the ensuing Joint ACI-ASCC Task Group that developed the survey questions. We also worked with Dean Frank, Executive Director of NEU: An ACI Center of Excellence for Carbon Neutral Concrete, and Michael Tholen, ACI Senior Managing Director of Technical Operations, to refine the questions.

This article presents 15 survey questions and a summary of answers provided by 173 respondents, as well as information from previous PLC surveys conducted by ASCC in March 2023,[1] the Tennessee Concrete Association (TCA) in June 2023,[2] and the National Ready Mixed Concrete Association (NRMCA) in October 2023.[3] Readers are encouraged to evaluate the ACI-ASCC PLC survey data and draw their own conclusions.

Survey Basics

The Joint ACI-ASCC Task Group developed survey questions to gather information regarding the construction of concrete floors and slabs using Type I and Type IL portland cement. The following paragraphs discuss survey distribution, sampling methods, and responses.

Distribution

ASCC's staff generated the survey in SurveyMonkey® and provided ACI staff with a URL link. The survey was distributed as an embedded link in the following media:

- Once per week in the Concrete SmartBrief—August 22 through September 30;
- In each ACI eNews—August 24 and September 7; and
- On ACI's LinkedIn and Facebook social media pages—August 16.

In addition, we (the authors) sent emails to our contacts at the Portland Cement Association (PCA), NRMCA, the California Nevada Cement Association (CNCA), and other groups to raise awareness of the survey and to encourage responses. The survey ended on September 30, 2023, with data collected from 173 respondents. While this may appear to be a small response, ACI staff has indicated that the largest previous survey, on the ACI Code 318 reorganization, included data from only 74 respondents.

Sampling

This survey featured nonprobability sampling based on links in emails to ACI members and contacts as well as postings on ACI's social media pages. Respondents had to take it upon themselves to submit responses, so the survey used a combination of convenience sampling and voluntary sampling. In contrast to the results of probability sampling based on random selection from a population, the results of this sampling approach are not suitable for statistical inference, and the results cannot be considered representative of all PLC users in the concrete industry.

Responses

The survey comprised multiple-choice questions, with each accompanied by a text box for comments. Table 1 summarizes

the quantities of responses and comments for each question. Because respondents could select multiple choices for many of the questions, the response rates exceed 100% for all but Questions 3 and 6. Respondents provided 288 comments. Although it is not practical to quote all comments in this article, a complete set is provided at **https://www.dropbox.com/scl/fo/4hox7s5jzvcud7rhied1e/h?rlkey=ml14in77igix8jn82qtight2e&dl=0**.

The Survey Says...(questions were edited for brevity)

Question 1: Select the profession that best describes your role in the concrete industry.

More than 80% of the respondents defined themselves as ready mixed concrete producers, concrete contractors, or architects/engineers. The remaining 20% of the respondents defined themselves as owners, testing agencies, construction manager/general contractors (CM/GC), or admixture and cement suppliers (Fig. 1).

Table 1:

Response quantities for survey questions 1 through 15

Question	Answered	Skipped	Responses	Comments
1	173	0	202	NA
2	173	0	314	NA
3	173	0	173	NA
4	82	91	82	NA
5	161	12	567	14
6	153	20	153	29
7	145	28	145	NA
8	138	35	500	38
9	136	37	193	16
10	154	19	374	25
11	137	36	354	21
12	135	38	265	NA
13	88	85	174	49
14	142	31	189	34
15	62	111	62	62
Total	2052	543	3747	288

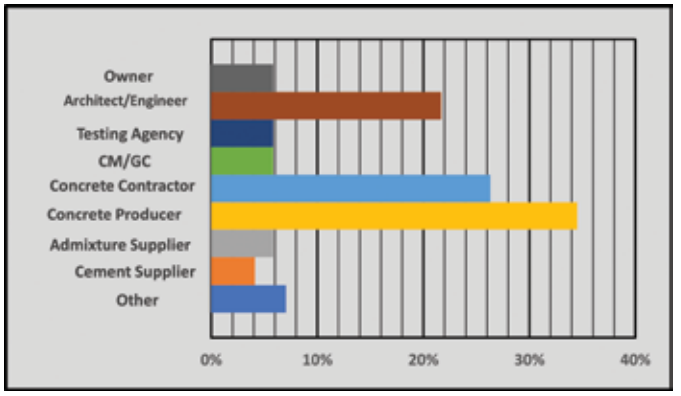

Fig. 1: Survey respondents by profession

Question 2: In what geographic region(s) does your company do business? (select all that apply)

Although it is not sufficient to establish causal relationships, this question provides an opportunity to determine if regional factors (for example, concrete constituents, climates, and construction practices) could be affecting project outcomes. Figure 2 shows the states that comprise each region, while Fig. 3 shows the responses by region.

Question 3: Do you have experience with the use of Type IL cement concrete for floor/slab construction?

Because the subsequent questions concern the use of Type IL cement in the construction of concrete floors, the response to this question verifies appropriate industry experience. Ninety-four percent of the respondents indicated that they have been involved in floor construction projects that included Type IL cement.

Question 4: If you have not used Type IL cement concrete, do you expect to use it in the next 6 months?

As shown in Table 1, 91 respondents skipped this question, and 82 responded. Ten respondents (about 12%) indicated that they do not anticipate using Type IL cement in the next 6 months.

Fig. 2: U.S. states representing each geographic region

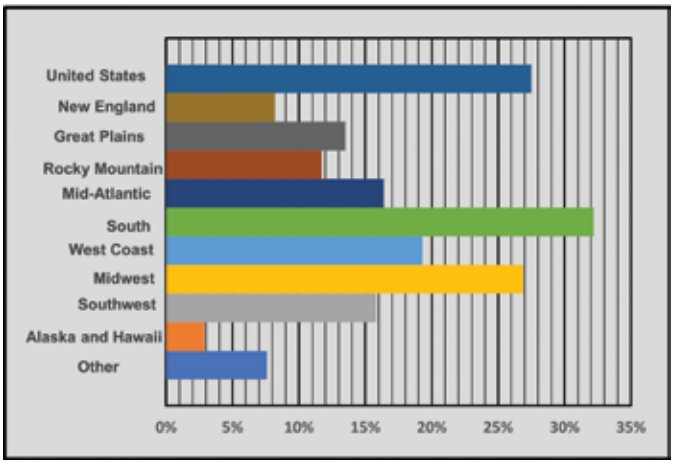

Fig. 3: Geographic regions in which respondents' companies operate

Question 5: With what types of floors/slabs do you have experience using Type IL cement concrete? (select all that apply)

The response to this question further establishes the legitimacy of the respondent's experience with floors. The 161 respondents provided 567 responses, an average of about 3.5 floor types per respondent. As shown in Fig. 4, over 90% of the respondents were familiar with interior slabs with a trowel finish, and over 80% were familiar with exterior slabs with a broom finish. Fewer respondents had experience with lightweight concrete (42%), topping slabs (44%), decorative (38%), or polished (45%) slabs. This was the first question that allowed for comments, and 14 comments were provided.

Question 6: If you used Type IL cement concrete, did you experience any problems? If so, did they occur at a greater, the same, or at a lower frequency than with Type I cement concrete? (choose one answer)

More than half the respondents indicated they had experienced problems more frequently with Type IL cement concrete than with Type I cement concrete (56%). Most of the remaining respondents reported that problems were occurring at the same frequency (43%), and a few respondents indicated that problems were occurring at a lower frequency with Type IL cement concrete than with Type I cement concrete (1%).

Table 2 shows responses to Question 6, categorized by the profession (industry role) of the respondent. Most of the responding cement producers (86%) and ready mixed concrete producers (60%) believe that problems experienced during the construction of concrete slabs and floors are occurring at the same frequency, regardless of the cement type. Admixture suppliers (89%), owners (80%), and concrete contractors (72%), however, believe problems are occurring at a greater frequency in floors constructed using Type IL portland cement. Clearly, perception is a function of perspective.

Comment summary: Of the 29 comments associated with Question 6, seven mentioned strength issues. Other problems mentioned were cracking; setting times, both retarded and accelerated; water demand; slump variation; scaling; and finishing. Special circumstances were also mentioned, including cold weather placements and use of high-performance concrete mixtures. Seven respondents commented that they had had no problems. One comment stated the belief that using Type IL on troweled slabs is a serious problem which requires study.

Question 7: Is there a cost difference between using portland-limestone cement (PLC) (ASTM C595/C595M4) concrete versus ordinary portland cement (OPC) (ASTM C150/C150M5) concrete?

Many surveys ask at least one question that is not understood or, in retrospect, not important. Question 7 is our albatross. We provided a slider bar so respondents could indicate cost differences ranging from –25% to +25%. But we also provided a text box—some respondents input cost difference as a percentage and others as a dollar value. Although 145 respondents provided answers, we could not calculate percentages based on dollar inputs. We also recognized after the fact that the cost difference isn't relevant.

Question 8: Compared to OPC concrete, did you experience any of the following when using PLC concrete, an increase or decrease in: (a) water demand, (b) set times, (c) bleed water, (d) crusting, (e) air content, (f) finishing, (g) pumping, (h) evaporation reducers, and (i) dry shakes? (select all that apply)

Figure 5 illustrates the choices as an increase or decrease in characteristics stated in the question. The top responses, with over 30% reported change, include water demand, set times, crusting, finishing, evaporation reducers, and bleeding.

Comment summary: The respondents provided 38 comments. Strength problems, cracking, water demand, and a need for more admixtures were the most commonly cited issues. Shrinkage, variation in slump, inconsistent setting, a short finishing window, scaling, saw-cutting issues, color matching difficulties, and problems arising with mixtures with SCMs were also mentioned. Nine of the 31 commenters experienced no differences.

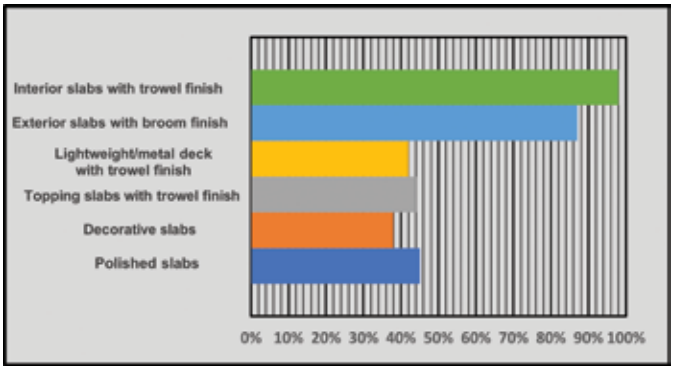

Fig. 4: Floor/slab types in which survey respondents used PLC concrete

Table 2:

Perception of occurrence of issues associated with change in cement type, tabulated by profession (role)

Profession	The same frequency, %	Lower frequency, %	Greater frequency, %
Owner	20	0	80
Architect/engineer	47	0	53
Testing agency	40	0	60
CM/GC	40	0	60
Concrete contractor	26	2	72
Concrete producer	60	2	38
Admixture supplier	11	0	89
Cement producer	86	0	14
Other	30	0	70

Question 9: Compared to OPC concrete, did you experience any of the following when using PLC concrete: similar amount of cracking or an increase or decrease in drying shrinkage cracking and plastic shrinkage cracking? (select all that apply)

While cracking can be a structural, durability, serviceability, or aesthetic issue (or of no concern), it invariably starts a jobsite discussion and thus is a good topic for a question. Figure 6 illustrates the responses to choices listed in the question. The 136 respondents provided 193 responses. While many respondents reported that they experienced the same amount of cracking regardless of the cement type, others experienced an increase in drying and plastic shrinkage cracking associated with PLC placements.

Comment summary: The 16 comments on this question varied with issues including location/weather, shrinkage cracking, use of SCMs, volume change behavior, full-depth slab cracking, and delamination. Four of the comments indicated no problems. One respondent solved the encountered problems with wet curing and wind barriers. Another believes that "proper finishing practices eliminate the issues."

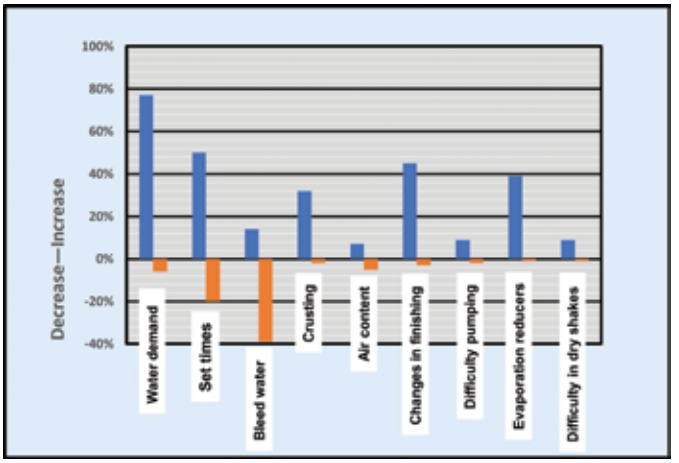

Fig. 5: Changes in characteristics observed by survey respondents when using PLC concrete versus OPC concrete. Positive (blue) bars indicate increased incidences, and negative (orange) bars indicate decreased incidences

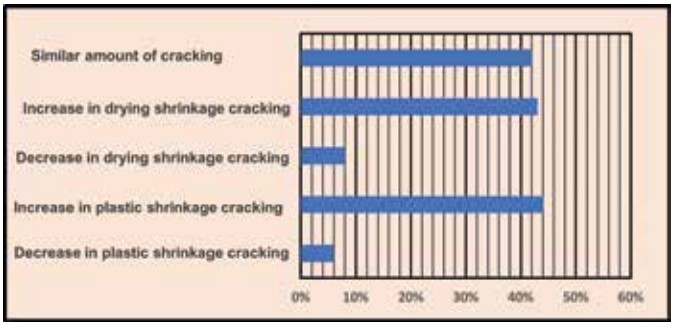

Fig. 6: Changes in cracking observed by survey respondents when using PLC concrete versus OPC concrete

Question 10: Compared to OPC concrete, did you experience any of the following when using PLC concrete: (a) no strength problems or an increase or decrease in strength at (b) 28 days, (c) 7 days, (d) 3 days, (e) after 28 days, or low strength that affected (f) construction, (g) form removal, or (h) post-tensioning stressing? (select all that apply)

As with cracking, low strength also generates jobsite discussions. Figure 7 illustrates the responses to choices listed in the question. Over 30% of the respondents reported they had experienced no strength problems. However, the same percentage of respondents reported that they had experienced strength problems at 28-, 7-, and 3-days.

Comment summary: Respondents provided 25 comments. While comments for this question were diverse, strength issues were cited as the number one problem. However, one respondent reported that strength problems were solved by using slag cement in mixtures. Six participants reported no problems with the queried topics. Others noted that improper curing or SCMs caused difficulties. Specific comments included:

- "…so many factors, it is hard to pin it all on PLC."
- "…material needs to be designed to meet performance criteria,"
- "…lab tests show similar performance on mix design work."

Question 11: Compared to OPC concrete, did you experience any of the following during ready mixed production when using PLC concrete: (a) no significant changes; or an increase or decrease in: (b) number of trial batches, (c) cementitious content, (d) admixture dosage, (e) admixture types, (f) fly ash content, (g) slag content, and (h) water demand? (select all that apply)

Specific to ready mixed concrete production, Fig. 8 illustrates responses to the choices included in the question.

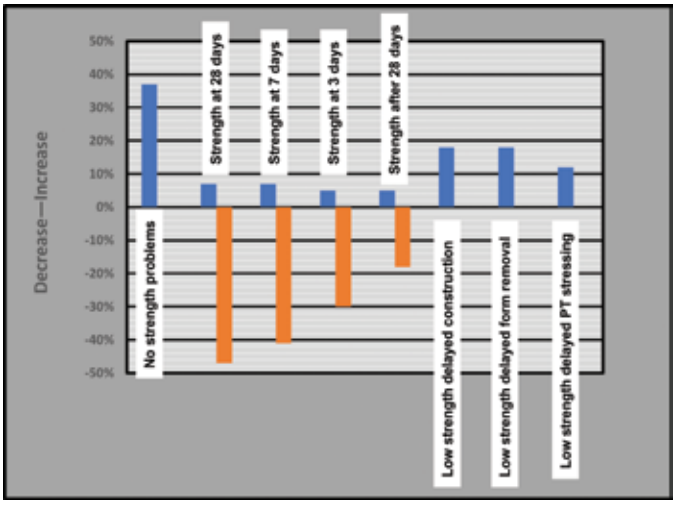

Fig. 7: Changes in strength development when using PLC concrete versus OPC concrete observed by survey respondents. Positive (blue) bars indicate increased strength, and negative (orange) bars indicate decreased strength

More than 20% of the respondents reported no significant changes. However, even greater percentages of respondents indicated that PLC mixtures led to increases in the number of trial batches, cement content, admixture dosage, and water demand. Both Questions 8 and 10 asked about water demand and received about the same response—an indication of consistency in the survey results.

Comment summary: Of the 21 comments provided for this question, those regarding admixtures ranged from "highly variable" to "very slight." Four comments indicated that the respondents had found no differences between OPC and PLC. Interesting remarks included:

- "We never accepted the industry message that it was the same."
- "The majority of producers have not done their due diligence, and have elected to do a 1:1 swap based on information from their cement salespersons."
- "This is a way more serious situation than the industry is making it out to be."

Question 12: Compared to OPC concrete, did you experience any of the following when using PLC concrete: (a) no significant changes; or an increase or decrease in: (b) random cracking, (c) wear resistance, (d) dusting, (e) scaling, (f) discoloration, (g) curling, and (h) delamination? (select all that apply)

The choices were based on Chapter 13 of ACI 302.1R-15.[6] Figure 9 illustrates responses to the question. The top response (at 50% of respondents)—no significant changes experienced. The second-place response (at about 35% of respondents)—increase in random cracking. The third-place result (at 20% of respondents)—decrease in wear resistance. Both Questions 9 and 12 asked about random cracking, receiving about the same response, again indicating consistency in the survey results.

Question 13: Compared to OPC concrete, did you experience any of the following when using PLC concrete: changes in (a) timing of saw cutting, (b) curing, (c) cold weather placement, and (d) hot weather placement? (select all that apply)

Figure 10 provides the percentages of respondents who indicated that changes were experienced in the indicated construction activity. Interestingly, 70% of the respondents reported changes in timing of saw cutting, and over 38% respondents reported changes in each of the other queried practices. While the question wasn't specific to the changes, respondents provided comments that were specific.

Comment summary: Forty-nine people commented on this question, with 17 saying they'd experienced slight to no differences. As for the other comments, the primary complaint (11 comments) was with the timing of joint saw cutting:

- "Water demand issues have resulted in us having to adjust our timing of saw cuts and amount of curl."
- "Intermittent setting and unpredictable set times…made timing the saw cuts difficult."

Other problems mentioned included increased water demand, shrinkage cracking, cylinder difficulties, finisher overtime, strength issues, and delamination.

Question 14: Compared to OPC concrete, did you experience any problems when using PLC concrete? If so, to whom do you most attribute the problems? (select one answer)

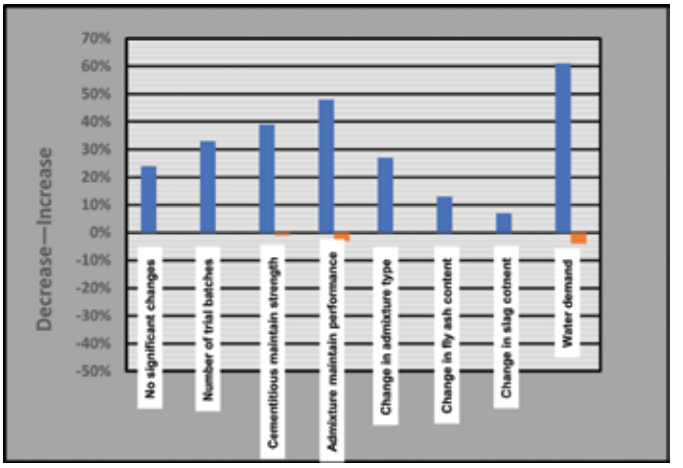

Fig. 8: Changes during ready mixed PLC concrete production versus OPC concrete production observed by survey respondents

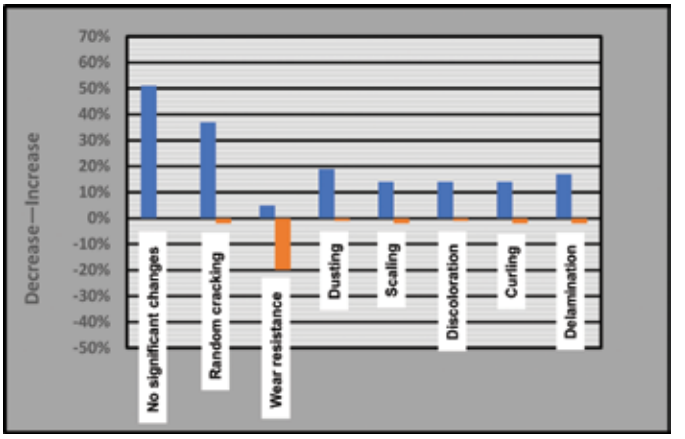

Fig. 9: Changes observed by survey respondents when using PLC concrete versus OPC concrete. Choices were based on Chapter 13 of ACI 302.1R-156

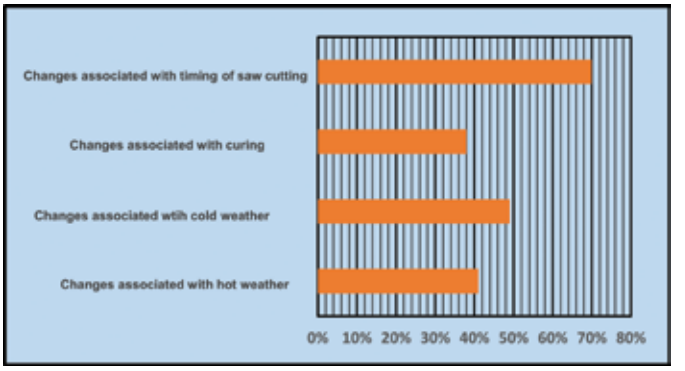

Fig. 10: Changes in specific construction activities when using PLC concrete versus OPC concrete observed by survey respondents

This was a perception question, as it asked owners, designers, contractors, ready mixed concrete producers, and cement suppliers to place blame for perceived problems. About 25% indicated that they had had no problems, while the majority (above 50%) expressed a belief that cement suppliers are the root of the issues. Table 3 provides the responses, listed by profession. Obviously, opinions vary with the respondents' roles.

Comment summary: There were 34 comments. Cement manufacturers and ready mixed concrete producers took the hardest hit with comments such as:

- "A lack of transparency on cement content/fly ash replacement."
- "The clinker is not getting ground enough, and the resulting cement performance is diminished."

Engineers/designers also received criticism such as:

- "It's a material issue; some Engineers have no experience with it and hold true to specifications that work for Type I/II but not with IL."

Also blamed were contractors, labs, the government, the industry at large, owners, and general contractors.

Question 15: Provide additional comments on floor and slab construction as appropriate for ACI Committee 302?

Comment summary: In response to this question, 13 of the 62 respondents indicated they had experienced few or no problems using PLC cement. The remainder included very specific concerns, solutions, or calls for honest communication:

- "There seems to be an increase in the frequency of reduced hydration at the surface."
- "We have recommended test slabs on all projects, which has successfully avoided issues."
- "Producing good IL takes good companies, people, and goals. We just need to start over creating mixes and not assume the material is the same as OPC regardless of what industry touted to get it going."
- "The issues with IL are evident everywhere and have to be highlighted. Problems in the field result in multiple lawsuits which is not what the industry wants."

ASCC, TCA, and NRMCA PLC Surveys

ASCC—The ASCC PLC survey, titled "ASCC Survey on Contractor Experience with Type IL Cement," consisted of 17 questions asking members to report their experiences with Type IL cement (PLC). The survey was sent out in December 2022. A total of 36 responses were received, and they were summarized in the March 2023 ASCC Newsletter.[1] The responses are presented in Tables 4 and 5 in this article. The respondents are structural concrete contractors located throughout the United States. Although company size varied, 22 contractors reported annual sales volume of more than

Table 3:
Problems with PLC concrete versus OPC concrete, attributed to specific professions by respondents' profession

Respondents' profession	We have had no problems, %	Owners, %	Designers, %	Contractors, %	Concrete producers, %	Cement suppliers, %
Owner	11	0	22	11	11	67
Architect/engineer	23	8	8	12	42	62
Testing agency	38	0	0	13	38	38
CM/GC	45	20	0	0	20	35
Concrete contractor	22	6	19	6	19	64
Concrete producer	33	6	17	21	2	42
Admixture supplier	0	0	14	29	14	86
Cement supplier	71	0	0	0	14	14
Other	0	11	22	0	55	89

Table 4:
ASCC Survey—Type I and IL cement use

Question	Yes	No	Type I only	Type IL only	Type I and IL	1:1 replacement	Other
Concrete contains Type IL cement	33	3	—	—	—	—	—
Cement types available	—	—	3	11	14	—	—
Content replacement of Type IL for Type I	—	—	—	—	—	18	1, 2, 3, 4, 5 (see footnotes)

1. Started at 1:1 but adding more Type IL as the strengths are about 5% lower
2. Depends on suppliers, some using 1:1 replacement, others adding an extra 20 to 30 lb (9 to 14 kg) of cement to maintain strengths
3. Replacing 1:1 Type IL for Type I
4. Increase Type IL by 100 lb (45.4 kg) over Type I to achieve same 4000 psi (27.6 MPa) strength at 28 days
5. Add about an extra half sack of cement for Type IL as compared to Type II/V to obtain same 28-day strengths

50 million USD. The survey focused on three main potential PLC problem areas: compressive strength, fresh concrete setting times, and water demand.

Respondents were also given the opportunity to describe other issues, including potential problems with finishability, shrinkage cracking, and effects of cold weather. No respondents indicated PLC issues related to decorative or polished concrete. It should be noted that some respondents declined to answer all questions.

TCA—The survey was sent out to TCA members from April to June 2023. The survey received 23 responses from 15 ready mixed concrete producers and eight concrete contractors. Nineteen responded that they had problems or changes when using Type IL cement. Twenty-one selected all that apply (refer to Fig. 11).

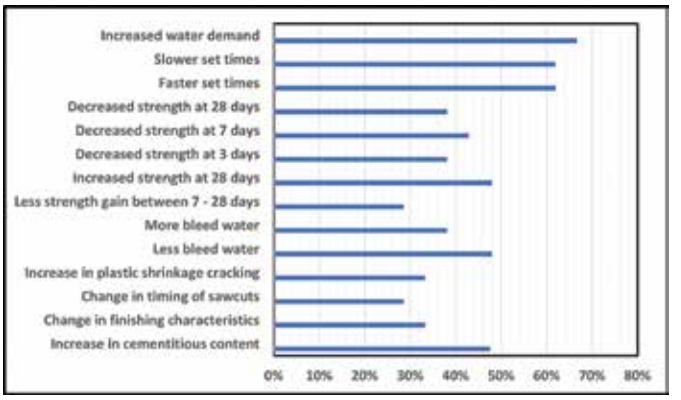

Fig. 11: TCA member responses on experiences with PLC concrete versus OPC concrete from 21 participants

Table 5:

ASCC Survey—strength, set time, water demand, and other issues

Question	Yes	No	Amount lower	
Have you had any strength issues with Type IL cement?	14	13	1. 5 to 10% lower; made strength at 56 days 2. About 10% lower 3. Up to 500 psi lower 4. Roughly 10 to 15% lower 5. Up to 25% lower 6. Up to 500 psi lower 7. 500 to 1000 psi lower 8. 10 to 15% lower 9. Increased cement content by half sack 10. About 200 to 400 psi at 28 days 11. Low 3-day by 10 to 15% 12. Low 3-day by 7% 13. Low 7-day by 10%	
Have you had any fresh concrete set issues?	14	14	Retarded	Accelerated
			1. 1 to 2 hours 2. Longer, made worse by cold weather 3. Longer by 45 to 60 minutes 4. Up to 2 hours 5. 30 minutes 6. Longer by 20 to 30% 7. Longer by 60 to 90 minutes	1. 10 to 15% faster 2. Faster by 25% 3. Faster 4. Faster by 30 to 60 minutes when pumping
Have you had any issues with increased water demand?	10	14	Comments	
			1. Much higher water demand; shrinkage cracking and workability issues 2. Drinks up water, makes it hard to flow. Spend more time working it, and less time finishing it. Creates more man hours per job 3. About 2 to 10% increase in water 4. Requires more water, makes strength less 5. More shrinkage cracking due to water demand 6. Batch plant confirms more water or water reducer used	
Other issues with Type IL cement?			Comments	
			1. Abrasion (2) 2. Finishability (11) 3. Workability (4) 4. Proper curing (4) 5. Cold weather work (10) 6. Shrinkage (6) 7. Pumpability (1) 8. Availability (2) 9. Cost premiums (4)	

Note: 100 psi = 0.7 MPa

NRMCA—During the summer of 2023, a phone survey was conducted to assess NRMCA producers' experiences with PLC. The survey was summarized in October 2023 and presented at NRMCA's ConcreteWorks (refer to Tables 6 and 7). Twenty-two companies were surveyed; six were vertically integrated producers, nine were large independent producers, and seven were small independent producers. The survey included nine, eight, and five producers in the Eastern (nine), Central (eight), and Western (five) geographic regions of the United States.

Table 6:
NRMCA Survey—PLC information

Question	Responses
Number of sources of cement	1. Sources varied from one to eight plus; some with more than one source at single plants; some imports 2. Several provided copies of mill test reports of OPC and PLC from same source
Availability of ASTM C150/C150M portland cement	1. 60% have only PLC 2. Some have sources that haven't switched; some have Type V availability; some imports
Information tracked or evaluated on PLC	1. Mill test reports are generally reviewed but not always useful for QC; reporting for ASTM C595/C595M is not too useful 2. Info reviewed included limestone (LS) content; Blaine fineness; SO3; alkali content; grinding aids; cube strength 3. 70% of PLC sources have LS content between 8 to 10%; others are at 10 to 15%; some sources indicate it will increase with time 4. Some concern of observed impact when LS > 10% 5. Blaine varies from 400 to 500+; change in Blaine not always consistent with LS content
ASTM C917/C917M for PLC (uniformity of single source based on strength)	1. 50% obtain and review; some sources don't have ASTM C917/C917M available 2. Generally, don't observe significant change in variability for individual sources
Evaluations performed with PLC	1. All performed trial batches; some compared OPC with PLC; some established 3-point curves; many evaluated production batches; most included SCMs and admixtures in additional trial batches 2. Some perform mortar tests; monthly concrete trial batches; calorimetry, some did more comprehensive evaluations—water demand, setting time, bleeding, admixture dosage and combinations; external testing included particle size distribution, composition, LS content, etc. 3. Some did durability testing—ASR, permeability—generally no issues
PLC content in mixtures	1. 70% indicated they used 1:1 replacement (generally with LS < 10%) 2. Some increased PLC 3 to 8% for 28-day strength; some have since reduced this; some SCMs work better with PLC for strength
SCM type and content	1. SCM used included Class C & F fly ash; slag cement; natural pozzolan 2. Generally, no changes to SCM content; some reduced for flatwork; some observed better SCM performance; some did not

Table 7:
NRMCA Survey—Impact of PLC on concrete

Question	Responses
Strength and strength gain	1. 50% noted lower 28-day strength; some see greater strength reduction with air-entrained mixtures
	2. 30% noted lower early-age strength
	3. Some observed strength flattens out after 7-days; some see later age strength gain
Water demand	1. Most observed increased water demand; 60% observed increases between 1 to 2 g/yd^3; adjusted with admixtures
Admixture dosage	1. 40% increase in water reducer (WR) dosage; most increase in air-entraining admixture dosage—some observed unstable air
	2. Source specific issues—WR not effective; admixture combinations WR and high-range WR or medium range WR combinations had to be changed
Setting time	1. 30% slightly retarded; 10% slightly accelerated; 60% no change or did not check
Changes to mixtures with PLC	1. 50% indicated no change; 20% increased cement 3 to 8%; some could live with reduced over-design
	2. Adjustments on admixture combinations and dosage

Table 7: Continued

Observed variability of PLC	1. 90% did not observe increased variability for individual sources; some indicated variability with changes in LS and fineness—observed general improvement from earlier supply when LS content was not changing
	2. Considerable variability between sources—issues with filling silos with varying source shipments
Evaluations with shipments	1. Most do not check or evaluate shipments
	2. 10% collect samples for mortar tests; most check changes in concrete mixtures
	3. Mill test reports not very useful for this purpose
Restrictions and required approvals/submittals	1. Some with Department of Transportation (DOT) initially; generally, not a problem if DOT approved PLC; most required some typical mixture data; some required production evaluation
	2. Many companies performed trial batches on most of their typical mixtures in preparation for required submittals
	3. Some issues with other designers (private construction) generally resolved with letters or new submittals; many due to lack of awareness or specification not referencing ASTM C595/C595M
	4. Restrictions on some U.S. Army Corps of Engineers and Federal Aviation Administration projects; environmental structures; hospitals; sulfate resistance requirements preference for Type V; lack of compliance with sulfate resistance for PLC, interior slabs
Perceptions of customers (contractors)	1. 10% indicated higher shrinkage; 10% indicated improved finishability; most indicate less bleed
	2. Concerns mentioned (not much basis for claims)—change in finishability for slabs; crusting; change in setting time; increased plastic shrinkage cracking; premature sealing; adjustments needed for early age strength (PT, tilt up, formwork)

Note: 1 g/yd^3 = 1.3 g/m^3

Survey comparison

Table 8 provides the responses to eight questions that were common to the ACI-ASCC, ASCC, TCA, and NRMCA surveys. The responses are in reasonable agreement across the surveys, further confirming the consistency of the ACI-ASCC survey results.

Table 8:
Comparison of survey responses

Issue	ACI-ASCC Fall 2023	NRMCA Summer 2023	TCA June 2023	ASCC December 2022
1. Strength, %	45	50	35	50
2. Water demand, %	75/60*	60	65	60
3. Set time, %	45	40	60	50
4. Bleed water, %	40	NA†	50	NA†
5. Plastic shrinkage cracking, %	45	X‡	35	30
6. Saw cut, %	70	NA†	30	NA†
7. Finishing, %	45	X‡	35	35
8. Cement content, %	35	20	50	NA†

*Question asked twice receiving a 75% and 60% response
†Represents survey did not ask question on this topic
‡Represents an issue but no percent reported

Cooperation and Collaboration

In December 2022, the CEO of the Portland Cement Association (PCA) encouraged cooperation and collaboration in efforts to produce sustainable concrete, stating that "working together is the vehicle to our success."[7] In December 2023, he further indicated that achieving carbon neutrality requires global collaboration among public and private sectors.[8] We certainly agree with these sentiments, and we believe that most survey respondents would also agree that cooperation and collaboration is an essential condition for the industry to move forward with sustainable concrete construction.

Although the Joint ACI-ASCC survey was based on a small sample size, we were discouraged to find that 80% of the owners say that concrete problems are occurring at a greater frequency with PLC than with OPC. We find hope, however, in a survey response calling for a summit meeting between PCA, NRMCA, and ASCC, adding:

- "This situation is very serious and needs to be addressed immediately."

We wholeheartedly agree and hope that a cement and concrete industry summit takes place no later than Summer 2024. We recommend that the ACI NEU Center of Excellence serve as the facilitator for continuing communication, cooperation, and collaboration.

References

1. Klinger, J., "ASCC PLC Survey," *The Voice Newsletter*, American Society of Concrete Contractors, St. Louis, MO, Mar. 2023.

2. Sparkman, A., "TCA PLC Survey," Tennessee Concrete Association, Antioch, TN, June 2023. (private communication)

3. Lobo, C., "NRMCA PLC Survey," National Ready Mixed Concrete Association, Alexandria, VA, Summer 2023. (private communication)

4. ASTM C595/C595M-23, "Standard Specification for Blended Hydraulic Cements," ASTM International, West Conshohocken, PA, 2023, 9 pp.

5. ASTM C150/C150M-22, "Standard Specification for Portland Cement," ASTM International, West Conshohocken, PA, 2022, 9 pp.

6. ACI Committee 302, "Guide to Concrete Floor and Slab Construction (ACI 302.1R-15)," American Concrete Institute, Farmington Hills, MI, 2015, 76 pp.

7. Ireland, M., "One Year Closer to a Carbon-Neutral Cement Future," *Concrete International*, V. 44, No. 12, Dec. 2022, pp. 40-41.

8. Ireland, M., "Navigating the Road toward Carbon Neutrality Globally," *Concrete International*, V. 45, No. 12, Dec. 2023, pp. 57-59.

Selected for reader interest by the editors.

ACI member **James Klinger** is a Concrete Construction Specialist for the American Society of Concrete Contractors (ASCC), St. Louis, MO, USA. He is a member of ACI Committees 134, Concrete Constructability, and 318, Structural Concrete Building Code; Joint ACI-ASCC Committee 117, Tolerances; and ACI Subcommittee 318-A, General, Concrete, and Construction. He was the recipient of the 2020 ACI Construction Award and the 2022 ACI Roger H. Corbetta Concrete Constructor Award. Klinger received his master's degree in structural engineering from the University of Maryland, College Park, MD, USA.

Kevin A. MacDonald, FACI, is President and Principal Engineer at Beton Consulting Engineers LLC, Mendota Heights, MN, USA. He is Chair of ACI Committees 302, Construction of Concrete Floors, and 306, Cold Weather Concreting, and Past Chair of ACI Committee 132, Responsibility in Concrete Construction. He is also a member of ACI Committees 211, Proportioning Concrete Mixtures; 212, Chemical Admixtures; 223, Shrinkage-Compensating Concrete; 232, Fly Ash and Bottom Ash in Concrete; 242, Alternative Cements; and 560, Design and Construction with Insulating Concrete Forms; as well as ACI Subcommittee 318-A, General, Concrete, and Construction. He received his BS in chemical engineering and his master's degree and PhD in engineering materials from the University of Windsor, Windsor, ON, Canada. MacDonald is a licensed professional engineer.

Jerry A. Holland, FACI, is Vice President and Director of Design Services for Structural Services, Inc., Atlanta, GA, USA, and has more than 55 years of worldwide experience in design, construction, and troubleshooting concrete materials, floors, pavements, other structures, and related geotechnical issues. He is an examiner for ACI Concrete Flatwork Associate, Finisher, and Advance Finisher Certification Programs. Holland is Past Chair of ACI Committee 360, Design of Slabs on Ground, and a member of ACI Committees C640, Craftsmen Certification; 223, Shrinkage-Compensating Concrete; 302, Construction of Concrete Floors; 325, Concrete Pavements; 330, Concrete Parking Lots and Site Paving; and 350, Environmental Engineering Concrete Structures. He is a licensed professional engineer.

Scott M. Tarr, FACI, is a Concrete Consultant and President of North S.Tarr Concrete Consulting, P.C., Dover, NH, USA. He is Chair of ACI Committee 360, Design of Slabs on Ground, and Past Chair of ACI Subcommittees 301-J, Shrinkage-Compensating Concrete – Section 10, and 301-K, Industrial Floor Slabs – Section 1. He also serves on ACI Committees 301, Specifications for Concrete Construction; 302, Construction of Concrete Floors; and 330, Concrete Parking Lots and Site Paving. Tarr is a member of the American Society of Concrete Contractors, International Concrete Repair Institute, American Society of Civil Engineers, American Concrete Pavement Association, and ASTM International. He received his BS and MS in civil engineering from the University of New Hampshire, Durham, NH, USA, and is a licensed professional engineer.

ACI Honorary Member **Beverly A. Garnant** is a former Executive Director of ASCC and Co-Chair of ASCC Sustainability Committee. She is a member of ACI Committees 134, Concrete Constructability; C641, Decorative Concrete Finisher Certification; and E703, Concrete Construction Practices.

Bruce A. Suprenant, FACI, is Chair of ACI Subcommittee 117-M, Movements Affecting Tolerances, and Vice Chair of Joint ACI-ASCC Committee 117, Tolerances, as well as a member of ACI Committees 134, Concrete Constructability; and 302, Construction of Concrete Floors. His honors include the 2022 ACI Concrete International Award, the 2021 ACI Arthur R. Anderson Medal, the 2020 ACI Construction Award, the 2013 ACI Certification Award, the 2010 ACI Roger H. Corbetta Concrete Constructor Award, and the 2010 ACI Construction Award.