MINUTES

RESPONSIBILITY IN CONCRETE CONSTRUCTION COMMITTEE

Westminster Room
Renaissance Grand and America’s Center
St. Louis, MO
Sunday, November 2, 2008
2:00 p.m. – 5:00 p.m.

MEMBERS PRESENT

Jeffrey Coleman, Chair    Mohammad Iqbal
Kenneth Bondy     William Klorman
Beverly Garnant     Eldon Tipping

VISITORS

Kevin MacDonald     Mike Schneider
Ward Malisch      Bruce Suprenant
Ross Martin

Michael L. Tholen, Staff Liaison

1.0 APPROVAL OF MINUTES AND AGENDA

1.1 Approval of Minutes of 2008 Spring Meeting—Los Angeles, CA

The Responsibility in Concrete Construction Committee (RCCC) approved the minutes of the meeting in Los Angeles, CA, held on March 30, 2008, as distributed.

1.2 Approval of Agenda

RCCC approved the St. Louis 2008 Agenda as distributed.

2.0 MEMBERSHIP
Chair Jeff Coleman announced two new members of the RCC Committee (Bev Garnant and Matthew Offenberg) and asked members and visitors to introduce themselves. Committee members Ava Shypula and Boyd Clark informed Chair Coleman that they would not be able to attend the meeting. Current member data are included in Exhibit 2.0.

3.0 ACTIVITIES OF THE COMMITTEE

3.1 Future Convention Session

The Committee-sponsored session, “Use and Misuse of ACI Documents,” will be held on Wednesday morning from 9:00 AM to 12:00 PM in room C-223. Boyd Clark was unable to attend the meeting but will be able to moderate the session. Chair Coleman informed the Committee that Michael Thomas was unable to attend the convention and would not be presenting at the session. Presentations will include:

- “Poor Specifications I Have Seen,” by Ward Malisch;
- “Use and Misuse of ACI Documents,” by Kenneth Bondy;
- “Developing Complete and Unambiguous Specification,” by Eldon Tipping;
- “How to Abuse and Misuse ACI 301,” by Calvin McCall;
- “The Adverse Effect High Cementitious Contents have on High-Strength Concrete,” by Casimir Bognacki; and

The session will conclude with a panel discussion.

3.2 New Responsibility Document

In Washington, DC, RCCC members decided to draft a new responsibility document, with task groups assigned to each of the different entities involved in a construction project: owner, design professional, general contractor, D-B contractor, subcontractor, specialty subcontractor, material supplier, testing/inspection, and forensic consultants. It was noted that each task group may publish opinion papers as they deal with issues during document development. The following motion was unanimously approved: “RCCC develop a new document, ‘Responsibility in Concrete Design and Construction,’ and to do so, establish nine task groups. Each task group is associated with an entity involved in construction. Each task group will have a chair whose responsibility it will be to draft an outline of each group’s goals 30 days before the San Francisco convention, and to report on these findings at the convention.”

In St. Louis, discussion centered on new language in the draft document prepared by Chair Coleman. In the introduction, it was noted that the reference to the Committee’s previous document should include the revisions published in the April 2005 edition of Concrete International. The Committee also discussed new language in Section 3.6 addressing responsibilities of the Design Professional when prescriptive and performance specifications are used. The review of this section
Responsibility in Concrete Construction Committee -MINUTES
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sparked discussion on how the responsibilities of other parties, including the contractor and material supplier, change for prescriptive versus performance specifications. This discussion included whether the responsibility for mixture proportions should default to the material supplier in performance specifications, whether there was a responsibility of the cement and admixture suppliers to supply consistent materials, and that the contractor should be responsible for determining performance specification parameters not included in the contract documents (such as workability, finishability, and pumpability). It was noted that the Design Professional should consider fit-up and tolerances. Finally, the definition of a Specialty Subcontractor was discussed. It was decided that the definition should include design of a portion of the completed work to differentiate from subcontractors that design other items, such as formwork.

The current task groups are as follows:

<table>
<thead>
<tr>
<th>Owner</th>
<th>Specialty Subcontractor</th>
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</thead>
<tbody>
<tr>
<td>Tom Malerk</td>
<td>Ken Bondy-Chair</td>
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<tr>
<td>Design Professional</td>
<td>Bill Klorman</td>
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<tr>
<td>Jeff Coleman-Chair</td>
<td>Chris Mosley</td>
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<tr>
<td>Ken Bondy</td>
<td>Material Supplier</td>
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<tr>
<td>Eldon Tipping</td>
<td>Colin Lobo-Chair</td>
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<tr>
<td>Chris Mosley</td>
<td>Ken Bondy</td>
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<td></td>
<td>Geoff Hichborn</td>
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<tr>
<td>General Contractor</td>
<td>Testing/Inspection</td>
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<tr>
<td>Jim Kretz-Chair</td>
<td>Ava Shypula-Chair</td>
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<tr>
<td>Bill Klorman</td>
<td>Geoff Hichborn</td>
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<tr>
<td>D-B Contractor</td>
<td>Boyd Clark</td>
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<tr>
<td>Bill Klorman-Chair</td>
<td>Eldon Tipping</td>
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<tr>
<td>Jim Kretz</td>
<td>Forensic Consultants</td>
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<tr>
<td>Subcontractor</td>
<td>Boyd Clark-Chair</td>
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<tr>
<td>Jim Kretz-Chair</td>
<td>Ken Bondy</td>
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<td>Ken Bondy</td>
<td>Bill Klorman</td>
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<td>Bill Klorman</td>
<td>Geoff Hichborn</td>
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<tr>
<td>Bev Garnant</td>
<td>Eldon Tipping</td>
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<tr>
<td>Geotechnical Engineer</td>
<td>Geoff Hichborn-Chair</td>
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The copy of the document with additional language by Chair Coleman that was discussed at the meeting is included in Exhibit 3.2.

**Action:** The task groups are asked to update their section of the document and submit them to Chair Coleman and Staff Liaison Tholen by January 1, 2009.

3.3 **Committee Assistance with TAC Review Process**

For the Fall TAC review cycles, only one document contained mandatory language.
ACI 423.X, “Specification for Testing of Cementitious Grouts for Post-Tensioning Tendons,” was reviewed by Colin Lobo. He did not find any responsibility issues that required comment.

In St. Louis, Bill Klorman indicated that he thought there would be some responsibility issues with an ACI 362 document that was submitted to, but not accepted by, TAC during this review session. It will need to be reviewed carefully if it is resubmitted.

3.4 Performance Specification and Responsibility

In Los Angeles, Ward Malisch and Bruce Suprenant asked the Committee to consider new responsibility concerns that may arise with increased use of performance specifications. Their concerns are outlined in the letter in Exhibit 3.4. Brad Inman noted that the P2P Initiative will not remove many of the potential conflicts between the contractor and the ready mixed concrete supplier and that the Committee will have to consider instances like the ones brought up in the letter carefully when putting together the new responsibility document. Eldon Tipping noted that Committee 117 is trying to develop realistic, achievable tolerances that he hopes will help alleviate some responsibility issues such as the one regarding concrete on metal deck mentioned in the letter.

In St. Louis, Malisch and Suprenant attended the meeting and stated that the intent of their letter was to point out that performance specifications may change the way we have traditionally assigned responsibilities. They also noted that a consistent, fair set of rules for responsibilities are the most important thing that can come out of the Committee. Chair Coleman pointed out that the contract language will have a large effect on who is responsible. Ken Bondy and Bruce Suprenant pointed out that the contractor should not be responsible for determining when the sequence of construction is important.

4.0 NEW BUSINESS

4.1 Canadian Standard CSA A23.1

In an email to Staff Liaison Tholen dated April 24, 2008, ACI Board of Direction member Claude Bedard pointed out that CSA A23.1 covers responsibility between the owner, contractor, and concrete producer in Table 5. In St. Louis, a copy of Table 5 was passed out for discussion. Kevin MacDonald also distributed Annex J of CSA A23.1, which is the “Guide for selecting alternatives using Table 5 when ordering concrete.” Chair Coleman suggested that a simplified table similar to Table 5 would be a helpful summary of responsibilities to include in the new Committee document. Copies of Table 5 and Annex J are included in Exhibit 4.1.
5.0 NEXT MEETING

The RCCC meeting at the San Antonio convention will be held on Sunday, March 15, 2009, from 2:00 to 5:00 p.m.

6.0 ADJOURNMENT

Attachments:
- Exhibit 2.0: RCCC roster
- Exhibit 3.2: Document draft discussed at meeting
- Exhibit 3.4: Letter from Ward Malisch and Bruce Suprenant
- Exhibit 4.1: CSA A23.1 Table 5 and Annex J
Responsibility in Concrete Construction Committee

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Responsibility in Concrete Construction
A Report by the ACI Responsibility in Concrete Construction Committee

1. Introduction

This document is intended as a guide for defining responsibilities of the various parties involved in concrete construction. The responsibilities of each party in a concrete construction project should be adequately described in the contracts between the parties. It is important that the party controlling that process (usually the Owner or an Owner's representative) make certain that the responsibilities of the parties are clear, coordinated and consistent. Clarity and consistency in the responsibilities defined in the contracts will reduce disputes over responsibility. This document is not intended to supersede the contracts between the parties, if there are inconsistencies between the parties’ contracts and responsibilities defined in this document, then the contracts between the parties govern the relationships and responsibilities.

The user of this document is encouraged to also review this committee’s report published in September 1995 in Concrete International. In particular the Committee continues to endorse the concept that responsibility should only be assigned where authority is also assigned and that each party should take responsibility for its own work.

2. Responsibilities of the Owner.

2.1 Ultimate Responsibility for the Entire Project.

As the final decision making authority, the Owner has ultimate responsibility for the entire construction project. Directly or indirectly all parties in the process report to the Owner.

2.2 Define the Project

The Owner is responsible for project definition, which includes establishing the scope and objectives of the project, the overall budget and project schedule. Further, the Owner is responsible for clearly communicating project requirements to the Design Professional developing the plans and specifications for the project. Should the project
requirements be changed, the Owner must be prepared to accept the costs and/or schedule consequences of the changes.

2.3 Provide Funding for the Project

Before entering into any stage of the project, the Owner must ensure that required funding, including a reasonable contingency reserve, is available.

2.4 Provide needed real estate, rights of way, permits, and insurance.

The Owner will provide the building site, all rights of way and easements for site access and utilities, all required construction related permits and insurance, unless otherwise delegated in the contract documents.

2.5 Beyond legally established codes and regulations, the Owner establishes quality and performance standards for the project.

The scope and objectives of the project, set forth by the Owner in contract documents, shall establish the quality level expected of the construction and any performance standards required by the Owner.

2.6 Establishes system for overall project management.

It is the Owner’s responsibility to establish the overall project management structure and clearly enunciate management and decision-making authority.

2.7 Selects key designers, managers, and contractors.

The Owner should establish and follow a fair and ethical procedure for selection of key members of the design and construction team.

2.8 Establishes quality assurance program

2.9 Provides overall site safety and security.

2.10 Makes agreed upon payments as project goals are met.

2.11 Accepts the completed project.

3. Responsibilities of the Design Professional

3.1 Performa all professional services including designing the work in accordance with the standard of care.
Design Professionals generally have the responsibility to perform their services, including designing the work, in accordance with the "Standard of Care." The Standard of Care is generally determined on a case-by-case basis; however, it can be defined in the contract between the parties. If not defined in the contract between parties, it is generally defined as the "the exercise of the skill and judgment which can be reasonably expected from similar situated professionals" and "to exercise such care, skill, and diligence as men in that profession ordinarily exercised under like circumstances." Thus, the Standard of Care creates a responsibility on the part of the Design Professional to perform their services in the same manner that a prudent designer would perform their services in a similar geographic area and in a similar timeframe.

3.2 Code Compliance with Applicable Codes.

Design Professionals have a responsibility to perform their services, including design of the project in accordance with applicable codes. However, there may be instances where the building code represents a minimum design standard. In those cases, the applicable Standard of Care may require that the Design Professional exceed minimum code requirements.

3.3 Coordinate with Other Design Professionals.

A lead Design Professional has a responsibility to coordinate its work with other subconsultant Design Professional. However, if the Owner has retained other Design Professionals under direct contract with the Owner, then the Owner has a responsibility to designate which of the multiple prime Design Professional has the responsibility to coordinate with the work of the various multiple prime Design Professionals.

3.4 Prepare Analytical and Design Justification (calculations) used for the preparation of Design Documents.

The Design Professional has a responsibility to prepare design calculations as appropriate and consistent with the Standard of Care. The Design Professional does not have a responsibility to issue or publish those calculations unless required by the contract documents, applicable codes, regulations or laws.

3.5 Provide Design documents for Construction, which should, at a minimum, include the following items: drawings, specifications.

The design documents are not expected to be perfect; however, the design documents should be adequate to describe the intended final outcome of the project and the final performance criteria of the components of the project and the over completed project.

3.6 Issue Material Specifications and Installation Specifications Considering Local Practice.
The Design Professional has a responsibility to specify the types of materials required for the project. The Design Professional should specify installation procedures that are necessary for the proper completion of the project. However, the Design Professional is not responsible for specifying the Contractor’s means, methods, techniques, sequences, or procedures, as those are the responsibility of the Contractor. There are however, instances where Design Professional musts specify means, methods, techniques, sequence and procedures so that the Contractor understands not only the materials to be provided for the project, but how these materials are to be installed so as to meet the Owner’s final criteria. *The Concrete mix, placement and curing shall be specified by the Design Professional in a prescriptive method detailing all requirements that are necessary for the intended strength and durability. Alternatively the Design Professional may specify the Concrete mix, placement and curing using performance based criteria. The Design Professional may, where necessary, specify a combination of prescriptive and performance based criteria. The responsibility of the Design Professional in a combined performance and prescriptive specification is to specify criteria that are consistent, compatible and possible to perform. (See Appendix A for Prescriptive vs. Performance specifications)*

3.7 Provide field Observation if required in the Owner’s Contract and/or Applicable Codes, Regulations, or Local Laws.

The Owner is responsible for determining the amount of field observation that the Design Professional will provide, and the Owner is responsible for paying an adequate fee to allow such field observations.

3.8 Perform all Inspections, Observations, and Reviews of Construction On-Site if required by the Contract or Applicable Codes, Regulations, or Laws.

3.9 Perform Shop Drawing Review in Accordance with the Terms and Conditions of the Contract Between the Design Professional and the Owner.

3.10 Understand and convey the Owner’s requirements in the Plans and Specifications.

The Design Professional should endeavor to fully understand the Owner’s requirements; however, the Owner has a responsibility to communicate those requirements and also has the responsibility to accept the cost and/or schedule consequences of changes in those requirements.

3.11 Review Submittals for General Contract Compliance if Required by the Contract between the Owner and the Design Professional.

3.12 Either Perform or Confirm Who Will Perform Special Inspections Required by Building Codes, if Applicable.
4. Responsibilities of General Contractor

Definition: A general contractor is a contractor whose scope of work includes the construction of a portion of the work. This work is described in the "general contract documents".

4.1 Construct the building in accordance with the contract documents and with the appropriate standard of care for general contractors in the geographical area of the work.

4.2 Contractors have no direct responsibility to engineering design requirements found in building codes.

4.3 Contractors conform to code design requirements by building in accordance with the contract documents.

4.4 Contractors have a right to assume that contract documents contain all applicable code and other requirements.

4.5 Call attention to any obvious errors or discrepancies in the contract documents.

4.6 Makes agreed upon payments to subcontractors and material suppliers as project goals are met.

4.7 Enter into contracts with sub-contractors that are consistent with the contract document requirements between the General Contractor and the Owner.

4.9 If a Prescriptive Specification is used, make sure that all requirements are passed on to the appropriate sub-contractor and/or material suppliers. If a Performance Based specification is used, determine who will be responsible for developing mix designs or other criteria that will achieve the specified performance criteria. If a combination of prescriptive and performance criteria are specified the Design Professional is ultimately responsible for the specification however the General Contractor should communicate with the Owner and Design Professional in writing if it is observed that the combined prescriptive and performance criteria are inconsistent, incompatible or impossible to perform.

4.10 Develop, maintain and administer a site safety program for the work.

5. Responsibilities of the Design-Build Contractor

6. Responsibilities of the Subcontractor
7. Responsibilities of Specialty Subcontractors

Definition: A specialty subcontractor is one whose scope of work includes the construction and the design of a portion of the work. The specialty subcontractor retains a licensed design professional to execute the delegated design work. Examples would include the design and construction of precast concrete elements or the design of and construction of all or part of cast-in-place post-tensioned floor systems.

7.1 Retain the services of a design professional (specialty engineer) with demonstrated expertise and/or experience in the type of work to be designed. Responsibilities of the specialty engineer include:
   a) Design the work in accordance with the standard of care for the design of similar works in the same geographic area.
   b) Prepare plans and specifications for the work that incorporate all applicable building code requirements, laws, and ordinances.
   c) Perform all contractually required inspections, observations, and reviews of placing and/or shop drawings.

7.2 Review the design for obvious errors or differences from generally accepted standard practices.

7.3 Construct the work in accordance with the plans and specifications prepared by the specialty engineer.

7.4 Construct the work in accordance with the standard of care for the work involved and in accordance with standard practices of similar subcontractors in the same geographic area.

8. Responsibilities of the Material Supplier.

8.1 Provide concrete (or other specified materials) that are consistent with the requirements of the Prescriptive Specification. If a Performance Specification is used, and the General Contractor requires it, develop a concrete mix (or other materials) that will achieve the performance criteria specified (See Appendix A).

9. Responsibilities of the Testing/Inspection Agency

10. Responsibilities of the Forensic Consultant
RCC Committee Members,

As performance specifications become more common, we believe that responsibility issues will become more complex. Although this letter discusses two specific examples, the point is that changing to performance specifications may make it necessary to view responsibility issues in a new light.

The P2P movement (Prescription to Performance specifications) will bring an even closer focus on responsibility in concrete construction. Concrete producers explain that they need to know what final criteria must be met so they can best meet those criteria using their expertise in choosing and using the component materials. To paraphrase Colin Lobo: “Don’t give us the cake recipe. Just tell us how what kind of cake you want.”

An analogous movement might even be forthcoming in the area of construction tolerances. Don’t tell the builders what tolerances we need for the different pieces. Just tell them how you want the pieces to function (no leakage at windows, for instance.) This also brings a closer focus on responsibility—in this case a responsibility not just for one player—the concrete producer—but shared by several members of the construction team.

Let us give you two examples of responsibility that we believe need to be better established. First let’s talk about performance concrete, specifically self-consolidating concrete. ACI 237R-07, “Self-Consolidating Concrete,” describes self-consolidating concrete as “highly flowable, nonsegregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation [we added this emphasis.]”

Let’s assume SCC is used for the walls in a water-retaining structure. No vibration is used by the contractor. And the results are as follows, in one lift only:

Who is responsible for the cost of repair or replacement? We can imagine this situation resulting in a finger-pointing exercise. The concrete producer may be accused of not supplying a sufficiently self-consolidating concrete. The concrete contractor may be accused of incorrectly installing the reinforcing steel, embeds, or both such that a congestion created dams through

Exhibit 3.4 – 1
which even self-consolidating concrete couldn’t flow. The design professional may be accused of creating too many lap splices in one area, and thus being responsible for congestion and the dam. The testing laboratory may be accused of not running the required on-site tests to ensure that the SCC was capable of being placed without consolidation. How will these responsibility issues be sorted out?

Now let’s talk about tolerances. Contractors are asked to place composite concrete floors on metal decking supported by a structural steel frame. This is usually unshored construction. ACI 302.1R-04 contains the following statements:

Section 3.3.2
The levelness of suspended slabs depends on the accuracy of formwork and strikeoff but is further influenced (especially in the case of slabs on metal decking) by the behavior of the structural frame during and after completion of construction. Each type of structural frame behaves somewhat differently; it is important for the contractor to recognize these differences and plan accordingly [Bold emphasis added].

The presence of camber in some floor members and the ACI 117 limitation on tolerances in slab thickness dictate that concrete be placed at a uniform thickness over the supporting steel. When placing slabs on metal decking, the contractor is cautioned that deflections of the structural steel members can vary from those anticipated by the designer. [Bold emphasis added]

Section 3.3.5.1
Unshored composite construction is the more common method used by designers because it is less expensive than shored construction. In unshored construction, the structural steel beams are sometimes cambered slightly during the fabrication process. This camber is intended to offset the anticipated deflection of that member under the weight of concrete. Ideally, after concrete has been placed and the system has deflected, the resulting floor surface will be level (Tipping 2002). [Bold emphasis added]

Levelness and elevation of the finished floor are affected both by formwork (contractor responsibility) and by dead-load deflection (design professional responsibility). But the statements in this document certainly seem to put most of the responsibility on the contractor to recognize differences in behavior of structural frames and to plan accordingly—even though thickness tolerances require an essentially uniform thickness. It is of little consolation that for cambered steel beams, “Ideally, after concrete has been placed and the system has deflected, the resulting floor surface will be level,” because the ideal is seldom if ever achieved. So who is responsible when the partitions don’t fit?

The RCCC responsibility document is silent on these points. But we don’t think it should be. And we realize that these are very sticky subjects.
Unfortunately, we will be unable to attend the RCC Committee meeting in Los Angeles, but we will plan on attending the meeting in St. Louis. It is our hope that a discussion can be started in Los Angeles regarding these important issues, and continued in St. Louis.

Sincerely,

Ward Malisch and Bruce Suprenant
<table>
<thead>
<tr>
<th>Alternative</th>
<th>The owner shall specify</th>
<th>The contractor shall</th>
<th>The supplier shall</th>
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<tr>
<td><strong>(1) Performance:</strong> When the owner requires the concrete supplier to assume responsibility for performance of the concrete as delivered and the contractor to assume responsibility for the concrete in place.</td>
<td>(a) required structural criteria including strength at age; (b) required durability criteria including class of exposure; (c) additional criteria for durability, volume stability, architectural requirements, sustainability, and any additional owner performance, pre-qualification or verification criteria; (d) quality management requirements (see Annex J); (e) whether the concrete supplier shall meet certification requirements of concrete industry certification programs; and (f) any other properties they may be required to meet the owner's performance requirements.</td>
<td>(a) work with the supplier to establish the concrete mix proportions to meet performance criteria for plastic and hardened concrete, considering the contractor's criteria for construction and placement and the owner's performance criteria; (b) submit documentation demonstrating the owner's pre-qualification performance requirements have been met; and (c) prepare and implement a quality control plan to ensure that the owner's performance criteria will be met and submit documentation demonstrating the owner's performance requirements have been met.</td>
<td>(a) certify that the plant, equipment, and all materials to be used in the concrete comply with the requirements of this Standard; (b) certify that the mix design satisfies the requirements of this Standard; (c) certify that production and delivery of concrete will meet the requirements of this Standard; (d) certify that the concrete complies with the performance criteria specified; (e) prepare and implement a quality control plan to ensure that the owner's and contractor's performance requirements will be met if required; (f) provide documentation verifying that the concrete supplier meets industry certification requirements, if specified; and (g) at the request of the owner, submit documentation to the satisfaction of the owner demonstrating that the proposed mix design will achieve the required strength, durability, and performance requirements.</td>
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| **(2) Prescription:** When the owner assumes responsibility for the concrete. | (a) mix proportions, including the quantities of any or all materials (admixtures, aggregates, cementing materials, and water) by mass per cubic metre of concrete; (b) the range of air content; (c) the slump range; (d) use of a concrete quality plan, if required; and (e) other requirements. | (a) plan the construction methods based on the owner's mix proportions and parameters; (b) obtain approval from the owner for any deviation from the specified mix design or parameters; and (c) identify to the owner any anticipated problems or deficiencies with the mix parameters related to construction. | (a) provide verification that the plant, equipment, and all materials to be used in the concrete comply with the requirements of this Standard; (b) demonstrate that the concrete complies with the prescriptive criteria as supplied by the owner; and (c) identify to the contractor any anticipated problems or deficiencies with the mix parameters related to construction. |

*The owner may accept ready-mixed concrete association certification programs such as provincial or regional ready-mixed concrete association facility certification programs (e.g., Atlantic Provinces Ready Mixed Concrete Association — APRMCA Concrete Production Facilities Certification Program, Association Béton Québec — BNQ 2621-965, Ready Mixed Concrete Association of Ontario — RMCAO Approved Quality Plan, Manitoba Ready Mixed Concrete Association — Certificate of Conformance for Concrete Facilities, Saskatchewan Ready Mixed Concrete Association — SRMCA Concrete Production Facilities Certification Program, Alberta Ready Mixed Concrete Association — Alberta Certification of Concrete Production Facilities). These certification programs deal with materials, material handling, batching, mixing equipment, etc., ensuring the capability of the supplier to produce concrete as prescribed by each program. Note: Refer to Annex J for background information and guidance on the use of this Table.
Annex J (informative)

**Guide for selecting alternatives using Table 5 when ordering concrete**

*Note: This Annex is not a mandatory part of this Standard.*

**Definitions**

**Quality Assurance**
Verification that the requirements of an accepted Quality Plan are being implemented and met. QA activities should be performed by the owner's representative.

**Quality Control**
Activity of measuring (e.g., testing samples) and adjusting the methods of production to meet the requirements of the Quality Plan. QC can involve developing a system to ensure products or services are designed and produced to meet customer requirements. An objective of quality control can be to detect and prevent non-conformance through a management system for continuous improvement. With respect to concrete construction, it is the sampling, testing and inspection of the concrete by qualified personnel.

**Owner's Quality Plan**
Planning of activities performed by the owner, in order to assure the shareholders (private company) or the public (public organization) of the control of the concrete construction quality.

**Contractor's Quality Plan**
Planning of the activities performed by the contractor, to ensure the project meets the owner's specifications.

**Quality Control Plan**
Planning of the quality control activities of the contractor, by defining items such as sampling and testing frequency and alert or reject criteria for non-conformance.

**Pre-Construction and Pre-Placement Meetings**
Meetings involving construction team members, to review major items of concrete construction (preconstruction) and address specific issues related to concrete placement of an individual concrete element or placement period (pre-placement).

**Prequalification Testing**
Testing of concrete prior to the beginning of the construction phase, in order to assess that the concrete has the potential to meet the specified performance criteria.

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*July 2008 213*

**J.1 Introduction**
The purpose of this Annex is to provide background information and guidance to users of this Standard on the selection of either of the two alternatives for specifying and ordering concrete found in Table 5: performance and prescriptive. In particular, the focus is on the materials selection and the design of concrete mixtures for the performance option, and the enhancement of this approach in accordance with this Standard.

The advantage of the performance approach is that the contractors and materials suppliers are free to use their expertise, innovative talent, and other resources at their disposal to design and deliver the product in the most efficient and economical manner. This is consistent with the owner's interest, which is generally to own a structure which will fulfill his/her needs at reasonable cost. In most circumstances the owner has no vested interest in the nature of the constituent materials or the methods used, provided that the performance requirements are met.

The incorporation of performance language within this Standard began in the 1994 edition. In the 2004 edition, Table 5 was modified significantly, reducing the number of alternatives for specifying concrete to two through the elimination of the "common" alternative. Enhancements were also made in other areas of the Standard to facilitate the adoption of the performance approach for concrete construction and to remove the barriers to doing so. The performance and prescriptive alternatives now given in Table 5 are intended to provide a clear definition of the roles and responsibilities of the various parties when specifying concrete, and to emphasize the importance of the need for the concrete to perform as intended in both the plastic and hardened states.

Many challenges accompany such a significant change in the concrete materials and construction industry. These include the importance of ensuring clear understanding of the roles and responsibilities of all interested parties; the
need for formal quality control, quality assurance, and verification processes; and the importance of writing project specifications that capture the intent of the performance option and that clearly articulate the expected performance criteria in measurable or verifiable terms. This Annex contains information and direction on all of these issues.

J.2 Background

The early development of this Standard was based largely on empirical relationships between prescribed materials, mix designs, and construction methods and the corresponding overall performance of the concrete in service. The construction industry has since seen a move away from the prescriptive approach toward a performance approach. Furthermore, the “common” alternative has become a much less viable option, due to the lack of clarity in defining the roles and responsibilities for specifying the various mix design parameters and for assuming responsibility for the concrete mix proportions. In concert with this general direction, this Standard has, over several editions, acquired a combination of prescriptive and performance language.

The essence of an effective performance specification is that the performance requirements are stated in measurable terms, and that the ability of the finished product to meet those requirements can be verified at the time the construction is complete. In many instances the state of the art has not yet developed to the point where performance can be conveniently verified at the necessary time. For this reason, there are significant portions of the Standard, beyond the selection of materials and mix designs, that are likely to remain prescriptive in nature for the foreseeable future. However, for purposes of specifying and ordering ready-mixed concrete, it is believed that the adoption of a performance approach and the elimination of the “common” alternative are timely. Accordingly, the 2004 edition provides the owner with the option of following either the prescriptive or performance approach.

The purpose of this Annex is, therefore, to provide guidance and background information to the user when specifying and ordering concrete, with a view towards enhancing and facilitating a performance approach.

J.3 What is performance?

J.3.1 General

During the course of a construction project a number of parties will be involved in the production and construction of concrete, and the custody of the concrete and its constituent materials will change hands several times, with each custodian having the ability and opportunity to affect the final performance of the concrete. Therefore, each of the parties will have different and sometimes conflicting performance requirements. A definition of performance is DRAFT A23.1/A23.2 © Canadian Standards Association 214 July 2008 therefore paramount. Clauses J.3.2 to J.3.4 set out key terms and the criteria that must be taken into consideration when specifying concrete on a performance basis.

J.3.2 Performance concrete specification

A performance concrete specification is a method of specifying a construction product in which the final outcome is given in mandatory language, in a manner that the performance requirements can be measured by accepted industry standards and methods. The processes, materials, or activities used by the contractors, subcontractors, manufacturers, and materials suppliers are then left to their discretion. In some cases, performance requirements can be referenced to this Standard, or other commonly used standards and specifications, such as those covering cementing materials, admixtures, aggregates, or construction practices.

J.3.3 Prescriptive concrete specification

A prescriptive concrete specification is a method of specifying a construction product in which all processes, activities, materials, proportions, and methods used to achieve the intended final outcome are specified in mandatory language contained in the project specifications. The contractors, subcontractors, materials suppliers, and manufacturers must then follow a prescribed process and use prescribed materials and proportions to deliver the product.

J.3.4 Performance criteria

J.3.4.1 General

In order to accommodate the interests of the various parties, the measurement and verification of the performance of concrete should be defined in terms set out in Clauses J.3.4.2 to Clauses J.3.4.4.

J.3.4.2 Plastic state

The essential performance characteristics are
(a) uniformity;
(b) placeability;
(c) workability (the ability to be placed and consolidated to completely fill the forms without unacceptable surface blemishes, loss of mortar, colour variations, segregation, etc.);
(d) finishability (including limitations on the acceptable amount of bleeding); and
(e) set time.
For the most part, these performance characteristics will be of interest to the contractors, concrete suppliers, and subcontractors involved in placing and finishing the concrete.

**J.3.4.3 Hardened state**

The essential performance characteristics are

(a) physical properties of compressive, flexural, or tensile strength and modulus, as applicable;
(b) rate of strength development;
(c) durability in the expected service environment; this includes resistance to corrosion, scaling, deleterious expansion, chemical degradation, freeze-thaw attack, abrasion, and other deterioration processes to which the concrete may be exposed;
(d) volume stability (limitations on acceptable volume changes due to shrinkage, creep, and thermal differentials caused by heat of hydration);
(e) appearance and architectural characteristics (i.e., limitations on acceptable levels of shrinkage cracking);
(f) surface texture (non-slip finish, steel trowel finish, etc.); and
(g) geometrical requirements (i.e., flatness and levelness, slope for drainage, etc.).

For the most part, the properties of the hardened concrete will be of interest to the designer and owner, but in some cases, they will also be of interest to the contractor and concrete supplier.

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July 2008 215

**J.3.4.4 Specifying performance criteria**

The challenge when preparing a performance specification for concrete is to state performance requirements that can be satisfied and that can be measured by accepted industry standards and methods. Specifications are normally written by and for the owner, whose interest is usually, but not always, long-term. The required performance criteria must therefore be stated in terms that can be measured early in the life cycle of the concrete and can be used to verify at that time that the long-term performance criteria will be met. Hence, the verification process becomes an essential and critical part of the success of the performance approach. Without a comprehensive and reliable verification process, the owner’s performance requirements cannot be verified at the appropriate time, and the process is not workable.

**J.4 Roles and responsibilities**

**J.4.1 Performance specifications**

**J.4.1.1 Owner**

Prior to endorsing the use of a performance specification, the owner must have confidence that this approach will meet his/her objectives. This requires reliance on the design team to prepare an effective performance specification and on the implementation of a reliable quality assurance process that will verify that the performance criteria will be met.

The owner is therefore responsible for appointing a competent design authority and implementing an appropriate quality assurance process. Often responsibility for quality assurance will be delegated to the design authority.

**J.4.1.2 Design authority**

The designer is responsible for

(a) establishing the performance criteria, usually in consultation with the owner;
(b) preparing the technical specification that states the performance criteria in appropriate terms; and
(c) under the direction of the owner, conducting quality assurance and reviewing quality assurance reports, or both, to ascertain on the owner’s behalf that the performance criteria have been met.

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*216 July 2008*

**J.4.1.3 Contractor**

The construction team is responsible for procuring concrete and related materials and incorporating them into the structure in a manner that meets the performance requirements.

The contractor is also responsible for conducting appropriate and sufficient quality control to demonstrate and document that the performance requirements have been met. The quality control documents must be communicated to the design authority and owner in a manner, and according to a schedule, that will accommodate the quality assurance process.

**J.4.1.4 Concrete supplier**

The concrete supplier is responsible for procuring materials and producing concrete that will, in its plastic and
hardened states, meet the performance requirements. This includes responsibility for implementing a quality control program to demonstrate and document that the product as delivered is of appropriate quality and will meet the performance requirements.

Since in a typical construction project the custody of the concrete transfers from the supplier to the contractor while in its plastic state, a high degree of coordination is required between supplier and contractor to ensure that the final product meets the performance criteria and that the quality control processes are compatible and demonstrate compliance.

J.4.2 Prescriptive specifications
J.4.2.1 Owner
The owner is responsible for appointing a competent design authority and implementing an appropriate quality assurance process. Often responsibility for quality assurance will be delegated to the design authority.

The use of the prescriptive approach transfers responsibility for the prescribed materials and processes from the contractor and supplier to the owner and design authority. The owner is therefore responsible for ensuring that the prescribed materials and processes will meet the performance requirements.

J.4.2.2 Contractor
The construction team is responsible for supplying materials and conducting the work in accordance with the prescribed requirements.

The contractor is also responsible for conducting appropriate and sufficient quality control to demonstrate and document that the prescribed requirements have been met.

J.4.2.3 Concrete supplier
The concrete supplier is responsible for supplying concrete in accordance with the prescribed requirements, and for conducting appropriate and sufficient quality control to demonstrate and document compliance.

J.5 Selecting an alternative
J.5.1 General
In selecting an alternative for specifying concrete in accordance with Table 5, it is up to the owner and his/her representative to determine the relative merits, costs, and other implications (including intellectual property rights) associated with the prescriptive and performance approaches. To some extent this will involve a risk management approach.

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July 2006 217

J.5.2 Prescriptive environment
In a prescriptive environment, the owner and his/her representative must make decisions about the balance between capital investment and long-term maintenance costs. From a purely concrete materials perspective, this risk-based approach makes the owner responsible for matching long-term performance expectations with material selection and mix design parameters, and the owner must make conscious decisions about his/her front-end and life-cycle costs.

The owner empowers the consultant/architect to design a concrete structure that will meet certain performance criteria, considering primarily in the medium and long term. The consultant then prescribes the materials, quantities, mix design parameters, and methods to achieve the intended performance. The contractor, on the other hand, is most concerned with the short-term performance characteristics (e.g., plastic concrete and strength gain properties) that will most cost-effectively enable construction of the works. These properties need to be established to ensure the required medium- and long-term requirements are met. Key assumptions, therefore, include the following:

(a) The consultant is knowledgeable enough about the most cost-effective way to correlate the prescriptive directions/measures with the medium- and long-term performance.

(b) The general contractor will follow the prescriptive directions and plan construction methods and sequence without compromising the medium- and long-term performance.

In the prescriptive environment, the owner, through the consultant, takes the lead role in monitoring the materials and methods to determine that the prescription has been followed.

J.5.3 Performance environment
J.5.3.1 General
In a performance environment, the owner stipulates the required performance of the concrete and then relies on the contractor and his/her suppliers and subtrades to provide materials and methods to achieve the performance required. Superimposed on the owner's performance requirements, which normally focus on the medium to long term, are the contractor's short-term performance requirements.

A.1.1.2 J.5.3.2 Quality management
Exhibit 4.1-6

Verification of concrete quality to ensure performance to this Standard and the project specifications is the responsibility of the owner.

Quality plans must take into account that there are quality management elements both internal and external to the owner’s concrete acceptance requirements, and that these elements must be tailored to each specific project and the concrete performance that is being sought.

This includes ensuring that the contractor has in place an industry-recognized quality control (QC) plan (e.g., an ISO 9000 type of process) that prevents or corrects defects and nonconformity in the concrete, and that is commensurate with the size and complexity of the project. Care must be taken during the contractor selection and award stages of a project to ensure that contractors and suppliers are provided with the necessary incentives for the added effort and cost of maintaining such a QC process.

The external QC effort (e.g., inspection and testing for verification and acceptance) made by the owner must complement and balance the internal QC effort made by the contractor, ensuring that the contractor’s QC systems are in place, operating effectively, and preventing or correcting nonconformance.

In a performance environment, a higher level of responsibility is placed on the contractor and all of his/her suppliers (ready-mix, hardware, reinforcing steel, etc.) and subcontractors (formwork, reinforcing steel, pumping, placing finishing, etc.) for the internal QC effort. The owner, in turn, must balance this effort by reviewing the QC plans and records of primary contractors, subcontractors, suppliers, and secondary suppliers, and by conducting independent quality assurance, testing, and verification of concrete and other material properties to validate the results of the contractor’s processes. The owner should also undertake an independent audit of the quality management system.

DRAFT A23.1/A23.2 © Canadian Standards Association
218 July 2008

J.5.3.3 Components of specifications

Project or contract specifications must include pre-qualifiers and post-qualifiers. Pre-qualifiers include the experience, proprietary mix design performance record, testimonials, proposal evaluation, integrated quality control plan evaluation, contractor-to-subtrades communication plan evaluation, and other criteria necessary to allow the owner to place reliance on the contractor and suppliers and subtrades. Post-qualifiers include the qualitative or subjective evaluation, quantitative or objective evaluation, quality control results, quality assurance results, rationalization of discrepancies between quality control and quality assurance, and other criteria necessary for the owner to be satisfied that the performance criteria have been met.

Performance-based contract documents (owner-contractor) will typically include plans and specifications complete with
(a) clearly articulated and understood roles and responsibilities of all parties, including owner, consultant, contractor, supplier, subcontractors, testing agency, etc.;
(b) terms and conditions for interaction among owner, contractor, and supplier;
(c) clearly understood definitions of performance and point of delivery;
(d) pre-qualifiers (past performance and quality plan) and post-qualifiers (quality control and quality assurance);
(e) performance criteria — durability, architectural requirements, volume stability, strength, and structural requirements — and test methods and acceptance criteria;
(f) reference to (contractor-supplier) quality plan;
(g) penalties for non-compliance; and
(h) procedures for dispute resolution.

J.5.3.4 Verification process

An effective performance specification will require a comprehensive verification process in which quality control and assurance processes verify and ensure that the performance criteria are being met. There are two components of the quality control program. Some of the performance criteria are, of necessity, subjective in nature (e.g., appearance and freedom from surface blemishes). It will be necessary to define in some measurable way how the performance will be evaluated. Also, some parameters overlap into responsibility for design and serviceability (e.g., freedom from cracking). Again, it will be necessary to define these types of parameters in a way that can be effectively evaluated.

J.6 Contents of Quality plans

J.6.1 Owner’s Quality Plan

J.6.1.1 Prequalification

The project specification or quality plan may define some prequalification requirements, including:

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of concrete construction

July 2008 219

(a) certification required from the contractor, subcontractors, testing agency and suppliers.
(b) test results required as part of the prequalification of concrete;
(c) duration of the historic data required;
(d) type of samples for prequalification tests; samples prepared in laboratory or field conditions.
Some tests that may be included in a quality plan and approximate duration (lead time) are presented in Table J.1.

J.6.1.2 Contractor’s quality plan
The specification or Owner’s quality plan should define the requirements for the contractor’s quality plan, including:
(a) list of required elements to be included in the contractor’s quality plan;
(b) organization responsible for the review of the contractor’s quality plan;
(c) qualifications of the personnel reviewing the contractor’s quality plan;

J.6.1.3 Audits
The specification or Owner’s quality plan should define an audit plan of the General Contractor’s Quality Plan. Audits are required to verify that the General Contractor’s quality management system is implemented and effective. Owner’s audit plan should include:
(a) the organization responsible for the audits;
(b) independence and confidentiality measures required from the auditors;
(c) qualifications of the personnel performing the audits;
(d) frequency of the audits.

J.6.1.4 Acceptance Testing
Owner’s specifications should identify:
(a) the party responsible for acceptance testing with a reference to the tests required for acceptance;
(b) the qualifications of organization responsible for the test or inspection;
(c) the qualifications of the personnel performing the test or inspection;
(d) frequency of the test or inspection;
(e) timing and distribution of reports;
(f) appeal procedure.
Some acceptance tests that may be specified and approximate duration are presented in Table J.1.

J.6.1.5 Pre-construction and pre-placement meetings
The Owner’s quality plan should specify pre-construction and pre-placement meetings defining:
(a) Meetings schedule;

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220 July 2008
(b) Attendance list;
(c) Agenda (checklist)
Note: A typical checklist is found in “Best Practices guidelines for concrete construction”; OGCARMCAO; Revision 1.0; 2005.

J.6.1.6 Submittals
As required under the project specifications and by the specifying alternative selected from Table 5, documents are to be submitted to the owner in accordance with the owner’s and contractor’s quality plans.
Typical information required for the submittals may include:
(i) Identification of the concrete mix tested for prequalification;
(ii) Intended use of the concrete mix (part of the concrete structure);
(iii) Complete test report following the requirements of the standard used;
(iv) Historic data on the same or similar concrete mix for the same test for the specified duration.
When this data is not available prequalification tests can be conducted.
A typical concrete mix submittal form is presented in Figure J.1.

J.6.2 General Contractor’s Quality Plan
A general Contractors Quality plan should define contractor’s responsibilities and actions required to meet specifications. The management of the plan, including compliance with the Quality Plan and any modifications remain the responsibility of the General Contractor. A plan may be implemented wholly
or partially by a contractor, subcontractor, supplier or an independent organization. Responsibilities are presented in Table 5. Changes to the plan should be in writing and accepted in kind by the Owner. Acceptance of the contractor's quality plan does not exclude that changes may be requested by the Owner at any time, following observations from audits. A Quality Plan should include:

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July 2008 221

(a) Organization charts, roles and responsibilities, identification of the person in charge of Quality management for the project (this can include personnel for supplier and subcontractor as well as the contractor);
(b) document management and retention process;
(c) concrete construction processes, including placing, protection, finishing and curing;
(d) verification of concrete mixes and submittal(s) process;
(e) non-conformance management process including identification, reporting and procedure to correct and prevent reoccurrence;
(f) quality control testing and inspection plan complete with test results reporting;
(g) change management process.

Note: it is important that the change management process include a procedure for informing all parties of changes to the construction process or concrete mix design affecting performance and if required indicate how the quality control will be adjusted in order to assess how performance criteria will still be met.

**J.7 Summary**

The adoption of a performance approach to supplying concrete and building a structure will obviously be a departure from the traditional approach. Recent experience has demonstrated that success is achieved when the owner has confidence in the ability of the contractors and suppliers to meet the performance criteria, and the contractors and suppliers embrace the concept of quality control to the point where the quality control process not only identifies and corrects deficiencies, but provides persuasive evidence to the owner that the required performance will be met.