203.101 BUILDING COMPONENTS, SUBSTRUCTURE, FOUNDATIONS

This document contains requirements for foundation elements for a hospital building and is in alignment with the UniFormat II, Level 2 classification - A10. The document is subdivided into the following parts per the UniFormat II, Level 3 classifications.

UNIFORMAT II classification						MoP
Level 1 Major Elements		Level 2 Group Elements		Level 3 Individual Elements		Document Number
A	Substructure	A10	Foundations	A1010	Standard Foundations	203.101
				A1020	Special Foundations	
				A1030	Slab On Grade	

ELEMENT A1010, STANDARD FOUNDATIONS. Includes general design requirements for wall and column foundations, pile caps, footings and bases, excavation, backfill, and compaction. Specific items of note include:

1. Concrete materials
2. Formwork
3. Waterstops
4. Perimeter drainage system
5. Waterproofing
6. Contract document requirements
7. Testing and Inspections

ELEMENT A1030, SLAB ON GRADE. Includes general design requirements for standard normal weight concrete building slabs-on-grade. Specific items of note include:

1. Concrete materials
2. Admixtures
3. Curing
4. Vapor barrier
5. Floor Flatness and Floor Levelness
6. Contract document requirements
7. Testing and Inspections

ELEMENT A1010, STANDARD FOUNDATIONS

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PART 1 - GENERAL

1.01 OVERVIEW

A. Includes wall and column foundations, foundation walls, excavation, backfill, and compaction.

B. Does not include requirements for deep foundation systems.

PART 2 - DESIGN CRITERIA

2.01 GENERAL

A. Structural engineer shall design foundations in accordance with recommendations of the Geotechnical Engineer, and as applicable to the project.

1. Unless otherwise directed, Owner shall provide the Geotechnical Engineering report to design team and contractor.

B. The use of supplemental cementitious materials as directed by the structural engineer of record and in accordance with AC1 301 and ACI 318 is acceptable as long as strength, and appearance of finished materials are not compromised.

2.02 CONCRETE, GENERAL

A. Concrete design to be in accordance with ACI 301 and ACI 318.

B. **Compressive strength of concrete at 28 days shall be 4,000 psi, minimum**. Structural Engineer of record to provide design and calculations to meet project specific requirements.

C. Maximum water-cementitious materials ratio shall be 0.50.

D. Air Content shall not exceed 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.

E. Synthetic macro and micro-fiber are not permitted unless approved in writing by BJC Director of Design and Corporate Architect.

2.03 CONCRETE MATERIALS

A. Cementitious Material: Use cementitious materials of the same type, brand, and source, throughout project.

B. Normal weight concrete materials.

1. Cementitious materials.

    a. Portland cement shall meet the minimum criteria established in ASTM C 150. Type I is intended for general construction applications. Other Types II through V will be considered on a project basis.

        1) Fly ash is permitted in accordance with ASTM C 618, Class C. (Class C is most common in the St. Louis region. Fly ash produced from the burning of younger lignite or subbituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes.)

    b. Where concrete will be significantly exposed and where coloration of the concrete is an important design consideration, limit or avoid use of fly ash.
    c. Ground granulated blast-furnace slag is permitted in accordance with ASTM C 989, Grade 100 or 120. No ground granulated blast furnace slag from plant co-fired with hazardous or medical waste or tire-derived fuel.
    d. Use of other supplementary cementitious materials shall be approved in writing by the Owner.

2. Normal-weight aggregates shall comply with ASTM C 33, graded (severe weather region). Important to provide a well-graded aggregate mix for quality.

    a. Maximum coarse aggregate size Portland cement shall meet the minimum criteria established in ASTM C 150.

        1) Coarse aggregate size shall not exceed 1-1/2" nominal.
        2) Fine aggregate shall be free of materials with deleterious reactivity to alkali in cement. Use Meramec sand only.

Fine aggregates shall be lignite free and shall be specified as Meramec sand ONLY.

3. Water shall meet the requirements of ASTM C 94/C 94M, and be potable.

    a. Use chilled water or ice for hot weather conditions
    b. Use heated water for cold weather applications.

4. Admixtures.

    a. Use of chloride-containing admixtures is strongly discouraged because of their detrimental effects on embedded reinforcement and the possible degradation of concrete structures.
    b. Air-entraining admixtures may be permitted where increased resistance to freeze/thaw is important.

c. Chemical admixtures will be permitted upon approval by the BJC Corporate Architect. The following types are identified in ASTM C 494.

1) Type A: Water-reducing admixtures.
2) Type B: Retarding admixtures.
3) Type C: Accelerating admixtures.
4) Type D: Water-reducing and retarding admixtures.
5) Type E: Water-reducing and accelerating admixtures.
6) Type F: High-range, water-reducing admixtures.
7) Type G: High-range, water-reducing and retarding admixtures

C. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

D. Use of fly ash, pozzolan, ground-granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, is acceptable as long as the supplementary material does not exceed 40 percent of the Portland cement.

E. Exposed foundations. As-cast concrete texture imparted by form-facing material shall be arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projecting surface irregularities.

2.04 FORMWORK

A. Comply with recommendations identified in ACI 347R (as mandated by ACI 301) and limits identified in ACI 117 for tolerances for surface irregularities in the completed concrete work. ACI 117 recognizes four surface classes from ACI 347R and the design team shall designate where each applies. (ACI 301 sets Class A as the default class for surfaces permanently.)

1. Class A: For surfaces prominently exposed to public view, where appearance is especially important. Class A permits gradual or abrupt irregularities of 1/8 inch (3 mm).
2. Class B: For coarse-textured surfaces to receive plaster, stucco, or wainscoting. Class B permits gradual or abrupt irregularities of 1/4 inch (6 mm).
3. Class C: For permanently exposed surfaces without additional finish. Class C permits gradual or abrupt irregularities of 1/2 inch (13 mm).
4. Class D: For surfaces, usually permanently concealed, where roughness is not objectionable. Class D permits gradual or abrupt irregularities of 1 inch (25 mm).

B. Portion of concrete foundations exposed to view shall be formed with panel sections made from steel, glass-fiber-reinforced plastic, melamine resin coated plywood, or other approved non-absorptive smooth form material.

C. Chamfer exterior corners and edges of permanently exposed concrete.

2.05 WATERSTOPS

A. Provide flexible waterstops as required at concrete joints below grade to prevent the passage of water.

B. Design team and contractor shall consider joint movement and hydrostatic pressure when selecting an appropriate waterstop system. Verify the project requirements and conditions and specify an appropriate and acceptable waterstop system.

C. Performance characteristics. There are 2 major types of waterstops, those that are designed for joint movement and those that are not designed for joint movement.

1. Waterstops for non-moving joint types are those joints that include the horizontal cold-joint between a concrete footing and foundation.
2. Waterstops for moving joints types require a mechanical waterstop that is cast into the concrete and spans both sides of the joint to create a diaphragm. One side of the stop is embedded in the concrete during the first pour, with the other side temporarily exposed. When the next pour is made, the other half of the waterstop is encased in concrete. The centerline of the waterstop should be aligned with the center of the joint.

    a. The following are acceptable shapes of waterstops for normal joint movement conditions. Other shapes may be required for unique joint conditions.

        1) Ribbed type is a waterstop that has a series of raised ridges along each of the embedded ends.
        2) Dumbbell shaped is characterized by having large bulbed ends on each end of the waterstop.

D. Preferred waterstop material.

1. Non-moving joints

    a. Self-Expanding Butyl Strip Waterstops. Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, minimum 3/4 by 1 inch (19 by 25 mm).

2. Moving joints. Manufactured fibbed or dumbbell type min 3/8” thick by 6” wide.

    a. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
    b. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

2.06 PERIMETER DRAINAGE SYSTEM

A. Provide subsoil drainage at perimeter of building when recommended by the Geotechnical Engineer or as directed by BJC Corporate Architect or Director of Design.

1. When project entails the removal of a portion of the drainage system, design team shall indicate existing locations on plans and detail re-routing of new drainage system as required. Contractor shall verify existing drainage system and coordinate connection location and drainage direction. Cap any abandoned lines as necessary.

2.07 WATERPROOFING

A. Provide waterproofing system at walls below grade, including elevator pits and other subsurface locations as necessary. System includes but is not limited to the following:

1. Self-adhering membrane comprised of rubberized asphalt integrally bounded to polyethylene sheeting formed into flexible sheets.

a. Minimum thickness = 56 mils
b. Minimum sheet width = 3'-0"
c. Tensile strength (ASTM D 412) = 250psi minimum
d. Ultimate elongation (ASTM D 412) = 200% minimum
e. Hydrostatic Head Resistance = 75 feet minimum

2. Protection Course: As recommended by W.P. sheet MFR.
3. Termination Bars: Aluminum bars, minimum 1"x 1/8" thickness with pre drilled 9" minimum centers
4. Drainage Panels: Three dimensional, high impact polystyrene core and woven polypropylene monofilament filter fabric bonded to raised surfaces of the core

a. Compressive Strength = minimum 1500 psf

PART 3 - SPECIAL CONTRACT DOCUMENT REQUIREMENTS

3.01 GENERAL

A. Contractor shall submit approved mix design for each concrete mixture to Architect of Record, Structural Engineer of Record, and Owner.

B. Shop Drawings shall be prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shop drawings shall include but not be limited to the following:

a. Size and locations of all openings, inserts and sleeves.
b. Size and locations of all recesses and embeds.

c. Locations and dimensions of all construction joints.
d. Locations of all waterstops.

3.02 TESTING

A. Concrete Testing Service: Unless otherwise directed, **Owner will engage a qualified independent testing agency**, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, to perform material evaluation tests.

1. Concrete testing shall be provided as required by the governing building codes and as determined by the architect and structural engineer of record following ACI standards. Minimum concrete tests shall include strength, air entrainment, temperature and slump. Additional tests may be performed as necessary to suit project specific requirements. These tests shall be performed and samples shall be taken after all on site additives have been properly added and mixed (if allowed). On-site testing shall occur on concrete material near the middle of the truck's load. Construction Manager will be responsible for scheduling the tests and will be required to notify the Owner's representative a minimum of 48 hours prior to all placement of concrete.

2. Cylinder Tests: Concrete cylinders will be prepared and tested at a minimum rate of one set (1 set of cylinders is equal to a minimum of 4 cylinders) for every 25 cu. yd. placed each day and one additional set for every additional 50 cu. yd. placed in the same day. From the sets, one (1) cylinder shall be tested at 7 day and two (2) cylinders shall be tested at 28 days. The fourth cylinder is defined as a hold cylinder and will be made available for additional testing if necessary. Note: 56 day compressive strength test results exceed ACI and ASTM limitations and, regardless of the structural engineer's acceptance of the data, these results may be rejected by the Owner.

a. In the event 28 day concrete strength tests are not yielding results which meet the structural engineer's requirements, the Owner reserves the right to engage a qualified materials testing company to perform a minimum of three (3) un-announced batch plant inspections. The Owner may also engage a testing company to conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M. The Construction Manager shall be responsible for all costs associated with the testing of the materials, including the inspection costs.

PART 4 - PRODUCTS

4.01 GENERAL

A. Not applicable.

End of A1010 - Standard Foundations

ELEMENT A1030 - SLAB ON GRADE

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PART 1 - GENERAL

1.01 OVERVIEW

A. Includes standard normal weight concrete slabs-on-grade.

PART 2 - DESIGN CRITERIA

2.01 GENERAL

A. Design team shall engineer slabs in accordance with recommendations of the Geotechnical Engineer, and as applicable to the project.

1. Unless otherwise directed, Owner shall provide the Geotechnical Engineering report to design team and contractor.

B. All slabs-on-grade shall include an engineered compacted granular fill base course in accordance with the Geotechnical Engineer requirements.

C. All slabs-on-grade shall include a vapor barrier system, above the base course and immediately below the slab.

D. The use of supplemental cementitious materials as directed by the structural engineer of record and in accordance with ACI 301 and ACI 318 is acceptable as long as strength, and appearance of finished materials are not compromised.

E. Curing. The process in which interior concrete slabs cure plays an integral role in the performance of the finished floor material, especially with respect to adhesion. Slabs typically need to slowly cure in order to minimize cracking and maximize strength. Prevailing industry methods have utilized an applied chemical compound curing method to slow the rate of evaporation, however these chemicals void most flooring manufacturer's warranties since this has the potential to change the chemical composition of the concrete surface. While some exceptions will occur, it is the requirement of all BJC Planning, Design & Construction projects to cure interior slabs which will receive floor finishes by a water-cure method. In addition, sufficient time shall be provided in the construction schedule to allow the concrete to dry to a level that is acceptable to the flooring manufacturer's requirements AND to the flooring standards defined in this Manual of Practice.

> Coordinate concrete slab curing methods with finished flooring manufacturer. Chemical applications may need to be mechanically removed in order for flooring installer to accept the substrate.

1. If applied chemical curing compounds are used, contractor will be required to prepare substrates according to flooring manufacturer's requirements. This may include mechanical scarifying and grinding of the concrete surface.

2.02 CONCRETE

A. Air content of trowel-finished floors shall not exceed 3 percent as recommended by ACI 302.1R

B. Submit curing method of concrete slab to receive finished flooring prior to

1. Show full schedule impact for selected curing process. Include milestone dates for fully enclosed (watrertight) and start-up of building's mechanical systems.

2. Provide finish flooring manufacturer's letter of acceptance for selected curing process.

C. Compressive strength of concrete at 28 days shall be 4,000 psi, minimum. Structural Engineer of record to provide design and calculations to meet project specific requirements.

D. Maximum water-cementitious materials ratio for concrete slabs shall be 0.45.

E. Normal weight concrete materials. Use the following cementitious materials, of the same type, brand, and source, throughout project:

1. Cementitious materials.

a. Portland cement shall meet the minimum criteria established in ASTM C 150. Type I is intended for general construction applications. Other Types II through V will be considered on a project basis.

1) Fly ash is permitted in accordance with ASTM C 618, Class C. (Class C is most common in the St. Louis region. Fly ash produced from the burning of younger lignite or subbituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes.)

b. Where concrete will be significantly exposed and where coloration of the concrete is an important design consideration, limit or avoid use of fly ash.
c. Ground granulated blast-furnace slag is permitted in accordance with ASTM C 989, Grade 100 or 120. No ground granulated blast furnace slag from plant co-fired with hazardous or medical waste or tire-derived fuel.
d. Use of other supplementary cementitious materials shall be approved in writing by the Owner.

2. Normal-weight aggregates shall comply with ASTM C 33, graded (severe weather region). Important to provide a well-graded aggregate mix for quality.

    a. Maximum coarse aggregate size Portland cement shall meet the minimum criteria established in ASTM C 150.

        1) Coarse aggregate size shall not exceed 1-1/2" nominal.
        2) Fine aggregate shall be free of materials with deleterious reactivity to alkali in cement. Use Meramec sand only.

Fine aggregates shall be lignite free and shall be specified as Meramec sand ONLY.

3. Water shall meet the requirements of ASTM C 94/C 94M, and potable.

    a. Use chilled water or ice for hot weather conditions
    b. Use heated water for cold weather applications.

4. Admixtures.

    a. Use of chloride-containing admixtures is strongly discouraged because of their detrimental effects on embedded reinforcement and the possible degradation of concrete structures.
    b. Air-entraining admixtures may be permitted where increased resistance to freze/thaw is important.
    c. Chemical admixtures will be permitted upon approval by the PD&C project manager. The following types are identified in ASTM C 494.

        1) Type A: Water-reducing admixtures.
        2) Type B: Retarding admixtures.
        3) Type C: Accelerating admixtures.
        4) Type D: Water-reducing and retarding admixtures.
        5) Type E: Water-reducing and accelerating admixtures.
        6) Type F: High-range, water-reducing admixtures.
        7) Type G: High-range, water-reducing and retarding admixtures

F. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

G. Use of fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, is acceptable as long as the supplementary material does not exceed 40 percent of the Portland cement.

H. Provide subsoil drainage system under slab connected to perimeter drainage system when recommended by the Geotechnical Engineer.

I. Floor flatness and floor levelness requirements for projects shall consider the type of flooring to be installed. In some instances, the intended use of the space (surgery, imaging, laboratory, etc.) may require more stringent tolerances. Architect and

Structural Engineer shall coordinate the requirements. The following minimum values for floor flatness and levelness shall be followed for concrete slabs-on-grade.

	Specified Overall Values for floor flatness (F) and levelness (L)	Minimum Local Values (MLV) for floor flatness (F) and levelness (L)
Areas to receive resilient and/or thinset flooring	F(F) 35 F(L) 25	F(F) 24 F(L) 17
Other areas with common floor coverings	F(F) 25 F(L) 20	F(F) 17 F(L) 15
Non-critical areas - mech. elec. room, storage, etc.	F(F) 20 F(L) 15	F(F) 15 F(L) 10

2.03 VAPOR BARRIER

A. Sheet vapor retarder shall meet the requirements of ASTM E 1745, Class A, not less than 15 mils (0.38 mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive tape for all seams and penetrations.

1. Maximum water-vapor permeance value: 0.1 perms

B. Polyethylene sheets are not permitted as a suitable vapor barrier below concrete slabs.

2.04 SLAB REINFORCEMENT

A. Concrete slab shall include welded wire reinforcement as specified by the architect and/or structural engineer. Coordinate requirements with the recommendations of the geotechnical engineer for specific site conditions.

B. Synthetic macro and micro-fiber are not permitted unless approved in writing by BJC Director of Design and Corporate Architect.

PART 3 - SPECIAL CONTRACT DOCUMENT REQUIREMENTS

3.01 GENERAL

A. Refer to specification requirements for curing of concrete and moisture testing.

B. Identify and clearly dimension all recessed slab areas on drawings. Conditions may include but are not limited to equipment, raised access floor, utility trenches, walk-off mats, terrazzo flooring, prefabricated rooms, etc.

C. Identify conditions requiring additional slab thickness and/or additional reinforcing. Conditions may include but not be limited to entrances (frost slab), areas with heavy equipment, etc.

D. Architectural and Engineering requirements shall determine the specific submittal requirements for the project.

1. Welding certificates
2. Material certificates.
3. Concrete order/delivery (truck) ticket: Provide copies of all delivery tickets to Owner. Note on ticket whether specification and approved design mix allow for job site additives. Note on ticket initial discharge time and completion of discharge. Owner's independent testing agency may be review truck times for accuracy and compliance.
4. Material Test Reports.
5. Curing method of concrete slab to receive finished flooring.

    a. Show full schedule impact for selected curing process. Include milestone dates for fully enclosed (watrertight) and start-up of building's mechanical systems.
    b. Provide finish flooring manufacturer's letter of acceptance for selected curing process.

E. Concrete Testing Service: Owner will engage a qualified independent testing agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, to perform material evaluation tests.

1. Concrete testing shall be provided as required by the governing building codes and as determined by the architect and structural engineer of record following ACI standards. Minimum concrete tests shall include strength, air entrainment, temperature and slump. Additional tests may be performed as necessary to suit project specific requirements. These tests shall be performed and samples shall be taken after all on site additives have been properly added and mixed (if allowed). On-site testing shall occur on concrete material near the middle of the truck's load. Construction Manager will be responsible for scheduling the tests and will be required to notify the Owner's representative a minimum of 48 hours prior to all placement of concrete.
2. Cylinder Tests: Concrete cylinders will be prepared and tested at a minimum rate of one set (1 set of cylinders is equal to a minimum of 4 cylinders) for every 25 cu. yd. placed each day and one additional set for every additional 50 cu. yd. placed in the same day. From the sets, one (1) cylinder shall be tested at 7 day and two (2) cylinders shall be tested at 28 days. The fourth cylinder is defined as a hold cylinder and will be made available for additional testing if necessary. Note: 56 day compressive strength test results exceed ACI and ASTM limitations and, regardless of the structural engineer's acceptance of the data, these results may be rejected by the Owner.

    a. In the event 28 day concrete strength tests are not yielding results which meet the structural engineer's requirements, the Owner reserves the right to engage an independent materials testing company to perform a minimum of three (3) un-announced batch plant inspections. The Owner may also engage an independent testing company to conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM

C42/C42M. The Construction Manager shall be responsible for all costs associated with the testing of the materials, including the inspection costs.

PART 4 - PRODUCTS

4.01 GENERAL

A. Not applicable.

End of A1030 - Slab On Grade

END OF DOCUMENT 203.101

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RESPONSIBILITY MATRIX

The following matrix identifies those individuals, roles or departments responsible for maintaining the accuracy of the information and those responsible for providing input. Refer to Preface for detailed explanation.

	BJC HealthCare													Hospital/Entity				
	PD&C																	
	Corporate Architect	Corporate Engineer	Director of Planning	Director of Design	Director of Construction	Other:	Clinical Asset Management (CAM)	Risk Management	Real Estate	Ergonomics	Infection Prevention (IP)	Info Systems, Data, Telecom (IS)	Other:	Standards Review Committee	Facilities Engineering	Housekeeping	Security	Other:
Primary Authorship	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Secondary Authorship	☐	☒	☐	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

DOCUMENT REVISION HISTORY

The following able indicates the date the document originated and any subsequent revisions.

203.101 – Substructure, Foundations		
Issue	Description of Issue	Prepared by
2012 v1	Original Issue	G. Zipfel
2012 v2	Miscellaneous Review/Clarifications	G. Zipfel/B. Temple
2016 v1	reissued	G. Zipfel
2018 v1	Combined documents and renamed as 203.101	G. Zipfel