

2016 California Building Standards Code

Facilities Development Division
The Building Department for California's Hospitals

Material Testing and Condition Assessment for SPC-4D



May 25, 2016

Material Testing and Condition Assessment for SPC-4D

Why?

- These buildings were built before 1973 with local permits, therefore QA/QC for construction varies.
- Existing drawings quality varies, was the building built as shown on those drawings?
- Establish confidence in the material properties used in the analysis.
- As life of building extended indefinitely, provide equivalence to the SPC-4 buildings.

2016 California Administrative Code, Chapter 6 (CBC 2016)

2.1.2.1 Building Characteristics. Characteristics of the building relevant to its seismic performance shall be obtained for use in the building evaluation. This shall include current information on the building's condition, configuration, material strengths, detailing, and foundation type. This data shall be obtained from:

1. Review of construction documents;
2. Destructive and nondestructive testing and examination of selected building components; and
3. Field observation of exposed conditions to verify that field conditions substantially match the construction documents in accordance with data collection requirements in Section 3413A.1.3, or equivalent provisions in later editions of the CBC.

2016 California Administrative Code, Chapter 6 (CBC 2016)

The characteristics of the building shall be established, including identification of the gravity- and lateral-load-carrying systems. The effective lateral-load carrying system may include structural and non-structural elements that will participate in providing lateral resistance, although these elements may not have intended to provide lateral resistance. The load path shall be identified, taking into account the effects of any modifications, alterations, or additions.

The owner or the owner's authorized agent shall submit the following to the office for review and approval:

- 1. Complete set of construction documents.*
- 2. Field test report(s) in accordance with Section 2.1.2.2.*
- 3. Field observation report, which shall verify that field conditions substantially match the construction documents.*

Material Properties

2.1.2.2 Material Properties. The building evaluation shall be based on the strength and deformation properties of the existing materials and components. The strength of existing components shall be calculated using data on their configuration, obtained from the original construction documents, supplemented by field observations, and the test values of material properties. Where such effects may have a deleterious effect on component or structural behavior, allowances shall be made for the likely effects of strain hardening or degradation. Test values may be obtained from samples extracted from the structure, or from original materials and compliance certificates. The Office will determine the adequacy of the *test results based upon the approved material testing program.*

The materials testing program shall require approval by the Office prior to testing. Prior to performing destructive materials test and non-destructive tests requiring modification to existing conditions, the owner or the owner's authorized agent shall obtain a building permit.

The materials testing shall be in accordance with the California Building Code 2016 (2016 CBC) Section 3413A.1.3, or equivalent provisions in later editions of the CBC.

2016 California Building Code (CBC 2016)

3413A.1.3 ASCE 41 Section 6.2. *Modify ASCE 41 Section 6.2 with the following:*
Data Collection Requirements. *The extent of data collection shall be at Comprehensive level for all structures, including structures upgraded to SPC-4D. A testing program for materials properties testing program shall be pre-approved by the enforcement agent prior to commencement of material testing work. Previously approved material test results shall be permitted to be used to satisfy part of the comprehensive data collection requirements.*

Exception: *Data collection at Usual level shall be permitted for structures with SPC-2 or lower target performance objective.*

Tension testing of reinforcing bars shall be in accordance with ASTM A370 Annex A9. All test specimens shall be the full section of the bar as rolled (8-in. gage length) and shall not be reduced.

At test sample locations, structural members, slabs and walls shall be repaired to a state that is equivalent to their original condition.

For buildings built under an OSHPD permit based on the 1976 or later edition of the CBC, where materials properties are shown on design drawings and original materials test data are available, no materials testing shall be required when approved by the enforcement agent.

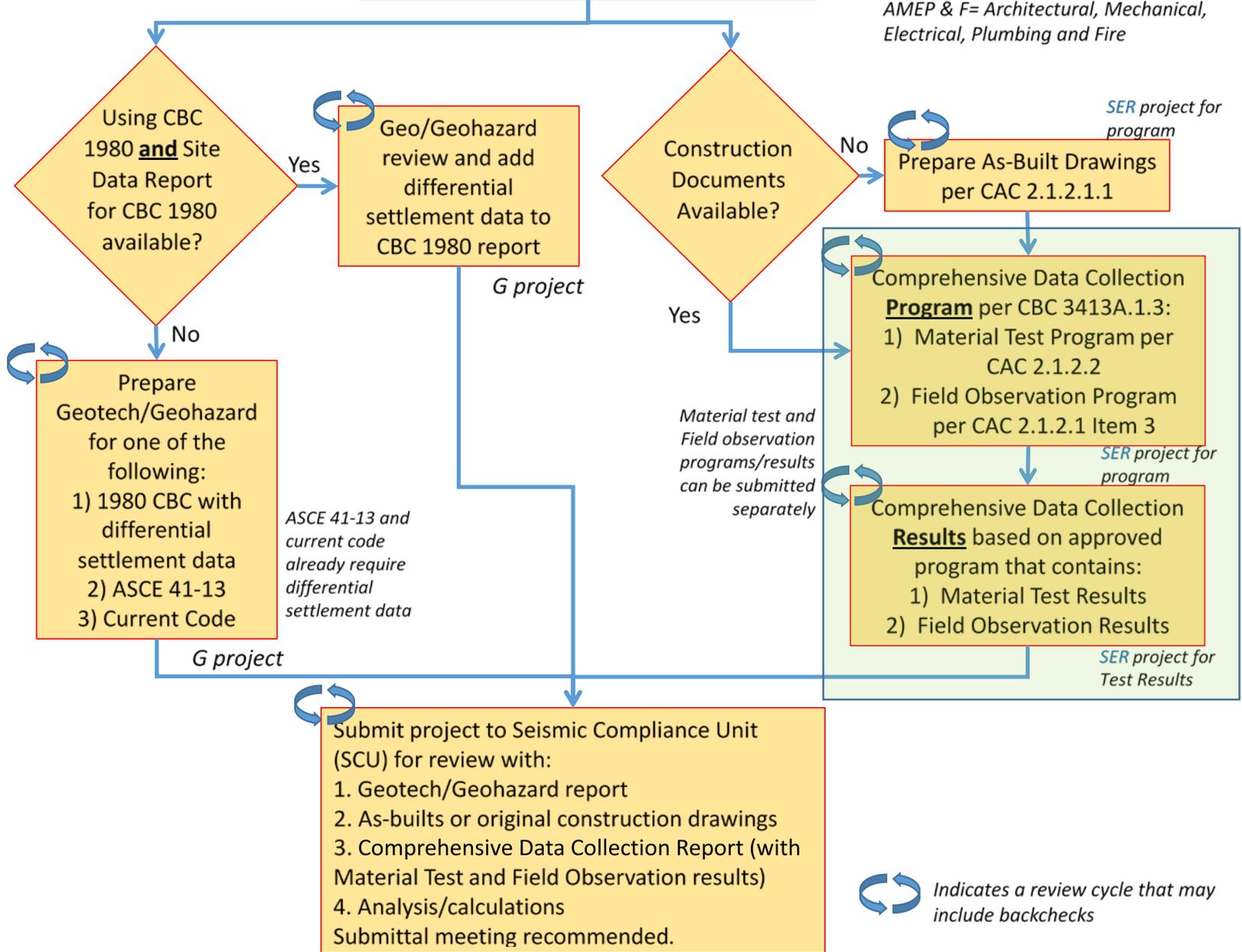
Terminology – MTCAP/MTCAR

Using ASCE 41-13 Terminology

- Material Testing Program
- Material Testing Results
- Condition Assessment Program
- Condition Assessment Results

SPC 4D Upgrade start with a pre-submittal meeting with Seismic Compliance Unit (SCU) if necessary

CAC = California Administrative Code
CBC = California Building Code
SRU, SER = Seismic Compliance Unit project types
AMEP & F= Architectural, Mechanical, Electrical, Plumbing and Fire

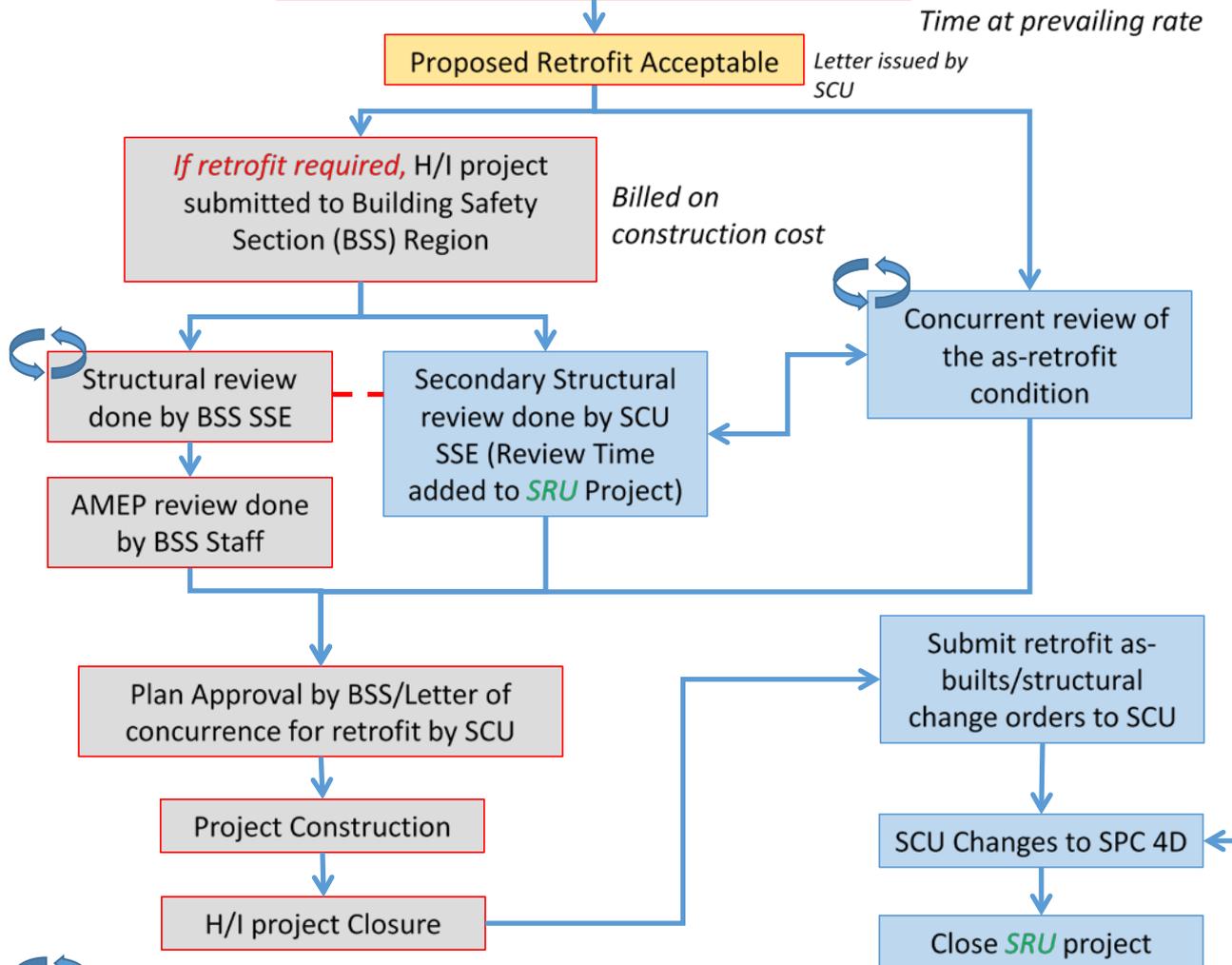


If SCU is busy, this may be assigned to key Senior Structural Engineer (SSE) in each region, however managed by SCU staff.

Submit project to Seismic Compliance Unit (SCU) for review with:
1. Geotech/Geohazard report
2. As-builts or original construction drawings
3. Comprehensive Data Collection Report (with Material Test and Field Observation results)
4. Analysis/calculations
Submittal meeting recommended.

If retrofit not required

SRU project title will have SPC-4D project # and Bld # - Billed on Time at prevailing rate



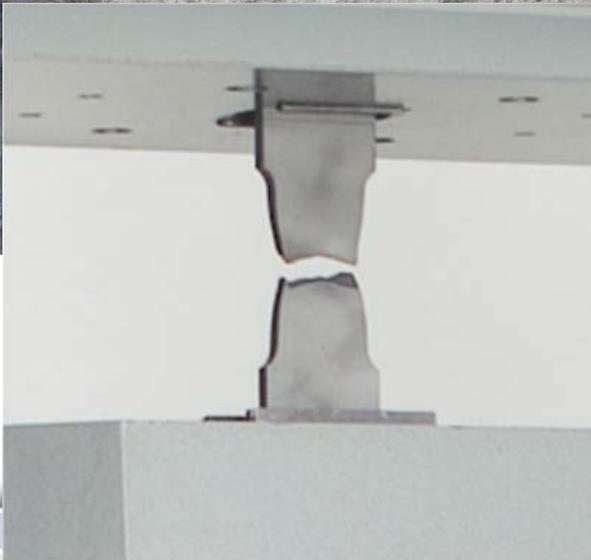
Indicates a review cycle that may include backchecks

MTCAP

- Emphasis will be on lateral elements even though CAC/CBC/ASCE 41 do not limit Material Testing or Condition Assessment to lateral elements only.
- A Standard Comment list for MTCAP is in the draft form and is currently being used in our reviews.

MTCAP Standard Comments Draft

Examples of Standard Comments



Comprehensive Condition Assessment

If construction documents including design drawings, specifications, material test records, and quality assurance reports covering original construction and subsequent modifications to the structure are incomplete, missing information shall be supplemented by a comprehensive condition assessment, including destructive and nondestructive investigation, in accordance with ASCE 41-13 Chapters 9 through 12.

The condition assessment program application may be submitted to the office as a separate project or combined with material testing application.

- Reference: ASCE 41-13 Section 6.2.3 Item 1 and 2 and 2016 CAC Chapter 6 Section 2.1.2.1

Comprehensive Material Testing

In the absence of material test records and quality assurance reports, material properties shall be determined by comprehensive materials testing in accordance with ASCE 41-13 Chapters 9 through 12, including the limitations on the coefficient of variation.

- Reference: ASCE 41-13 Section 6.2.3 item 3

Number of Steel Samples without construction drawings and specifications

At least two tensile strength coupons and two bolts and rivets shall be removed from each component type for every four floors or every 200,000 ft².

Component types include beams, columns, braces and metal deck. If it is determined from testing that more than one material grade exists, additional sampling and testing shall be performed until the extent of each grade in component fabrication has been established.

- Reference: ASCE 41-13 Section 9.2.2.4.2 Item 2

Report for Condition Assessment of steel elements

Provide a condition assessment report including the following items:

1. The physical condition of primary and secondary components and the presence of any degradation;
 2. Verification of the presence and configuration of structural elements and components and their connections, and the continuity of load paths among components, elements, and systems; and
 3. Identification of other conditions, including the presence of nonstructural components that influence building performance.
- Reference: ASCE 41-13 Section 9.2.3.1

Coefficient of Variation - Concrete

A minimum of three tests shall be conducted to determine any property. If the coefficient of variation exceeds 20%, additional tests should be performed until the coefficient of variation is equal to or less than 20%. If additional testing does not reduce the coefficient of variation below 20%, a knowledge factor reduction per Section 10.2.4 shall be used. Alternatively, the expected concrete strength can be determined using the mean less one standard deviation per ASCE 41-13 Section 10.2.2.3.1 as approved by OSHPD.

In determining coefficient of variation, cores shall be grouped by grades of concrete and element type. Note that no sample result can be excluded from the data set to reduce the COV unless a written documentation from the testing agency confirming that the sample was damaged prior to testing is submitted for review and approval by OSHPD. The testing lab shall provide reasons of any errors involved in the lab testing procedure including sampling, sample transportation, sample storing, calibration and operation of testing equipment etc.

- Reference: ASCE 41-13 Section 10.2.2.4.2.1 and ASCE 41-13 Section 10.2.2.3.1

Concrete Removal and Sampling Reference

Condition assessment exposure is defined as local minimized removal of cover concrete and other materials to inspect reinforcing system details. All damaged concrete cover shall be replaced after inspection.

- Reference: ASCE 41-13 Section 10.2.3.2.2

EXAMPLES OF PROGRAMS

Example: Condition Assessment Program

3.2. Required Number of Components and Connections to be Assessed

Per the original construction documents dated February 26, 1968, there are total of 18 visible components of LFRS:

- (6) 8" reinforced concrete shear walls;
- (6) 12"x24" and (5) 8"x22" concrete collector beams; and
- (1) 4 ½" concrete roof diaphragm.

Visual Condition Assessment:

- The total required number of visual condition assessment of components is based on the minimum of: 20% of the components at each floor level (for 18 components equivalent to $18 \times 20\% = 4$ components total);

A total of 4 components are proposed to be assessed, 1 from slab, 2 from concrete shear walls, and 1 from concrete beam.

Comprehensive Condition Assessment:

- A minimum of three different primary connections are required to be exposed to inspect reinforcing system details.

A total of 4 connections are proposed, 1 from diaphragm to shear wall connection, 1 from diaphragm to collector beam connection, 1 from collector beam to shear wall connections and 1 from foundation to shear wall connections. In addition the rebar spacing is verified in one of the concrete shear walls.

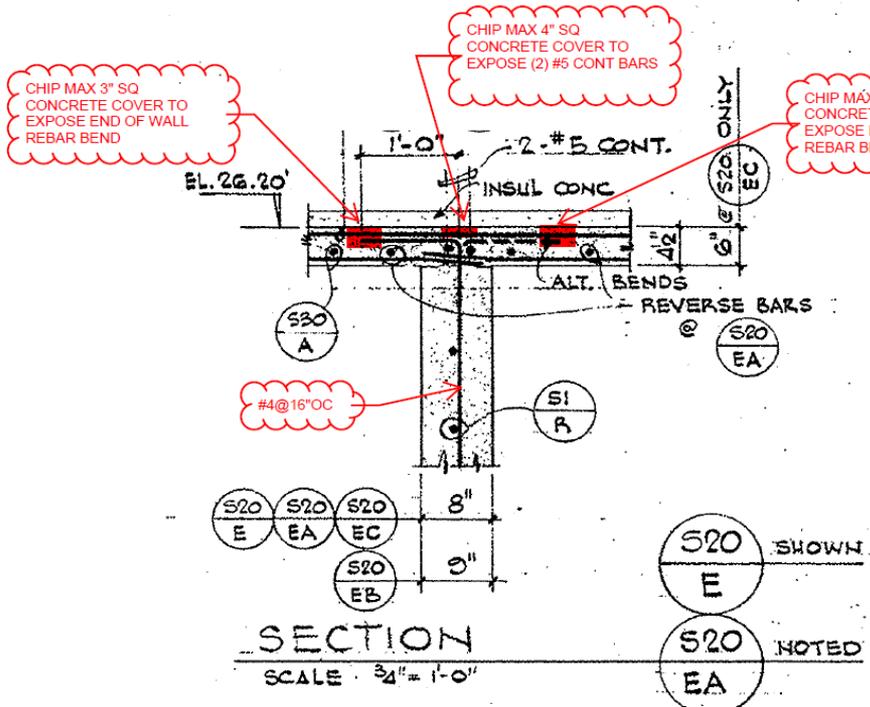
Example: Condition Assessment Program

3.4. Condition Assessment Requirements

The following requirements shall be met for the building.

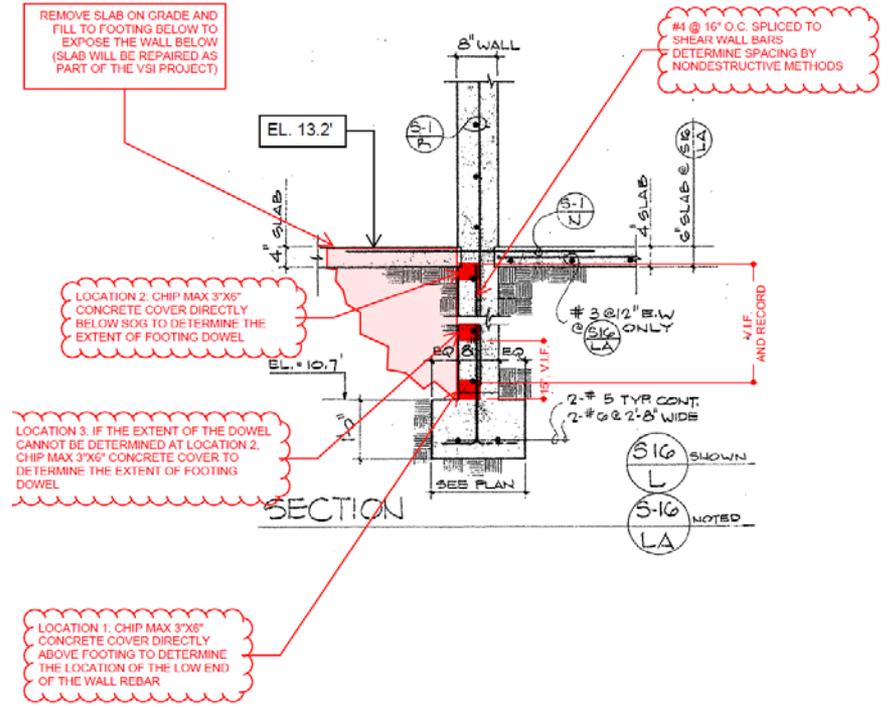
1. The process for conducting conditions assessment should be per Appendix B.
2. The condition assessment program will include:
 - i) *Grade Beams / Pile Caps (VN-V-PC-#)*: Three locations will be exposed to verify pile cap depth. Reinforcement will be scanned to verify spacing, and reinforcing size will be verified from testing sample (see Section 3.3).
 - ii) *Slab on Grade (VN-V-SG-#)*: Three locations will be exposed to verify slab-on-grade depth. Reinforcement will be scanned to verify spacing, and reinforcing size will be verified from testing sample (see Section 3.3).
 - iii) *Suspended Slab at Mezzanine Level (VN-V-SS-#)*: Three locations will be exposed to verify suspended slab thickness. Reinforcement will be scanned to verify spacing, and reinforcing size will be verified from testing sample (see Section 3.3).
 - iv) *Mezzanine Beams (VN-V-CB-#)*: At least three locations will be inspected with non-destructive testing to confirm the width and depth of beams, as well as the spacing of steel reinforcement.
 - v) *Piles (VD-V-P-#)*: Per Section 3.3, only one pile will be exposed to verify the following items: longitudinal reinforcing size and embedment into pile cap; size and pitch of pile spiral reinforcement.
 - vi) *Wall-Footing Joint (VD-V-FC-#)*: At least three locations will be exposed to verify dowel size and spacing and to confirm wall lap splice dimensions. Reinforcing shall be exposed by removing cover concrete and other materials to allow inspection of the reinforcing steel. All exposed reinforcing sizes and spacing will be documented.
 - ii) *Concrete Walls @ 1st Floor (VN-V-CW-#)*: Three locations at the first floor level will be exposed to verify wall thickness. Vertical and horizontal reinforcement

CAP Details

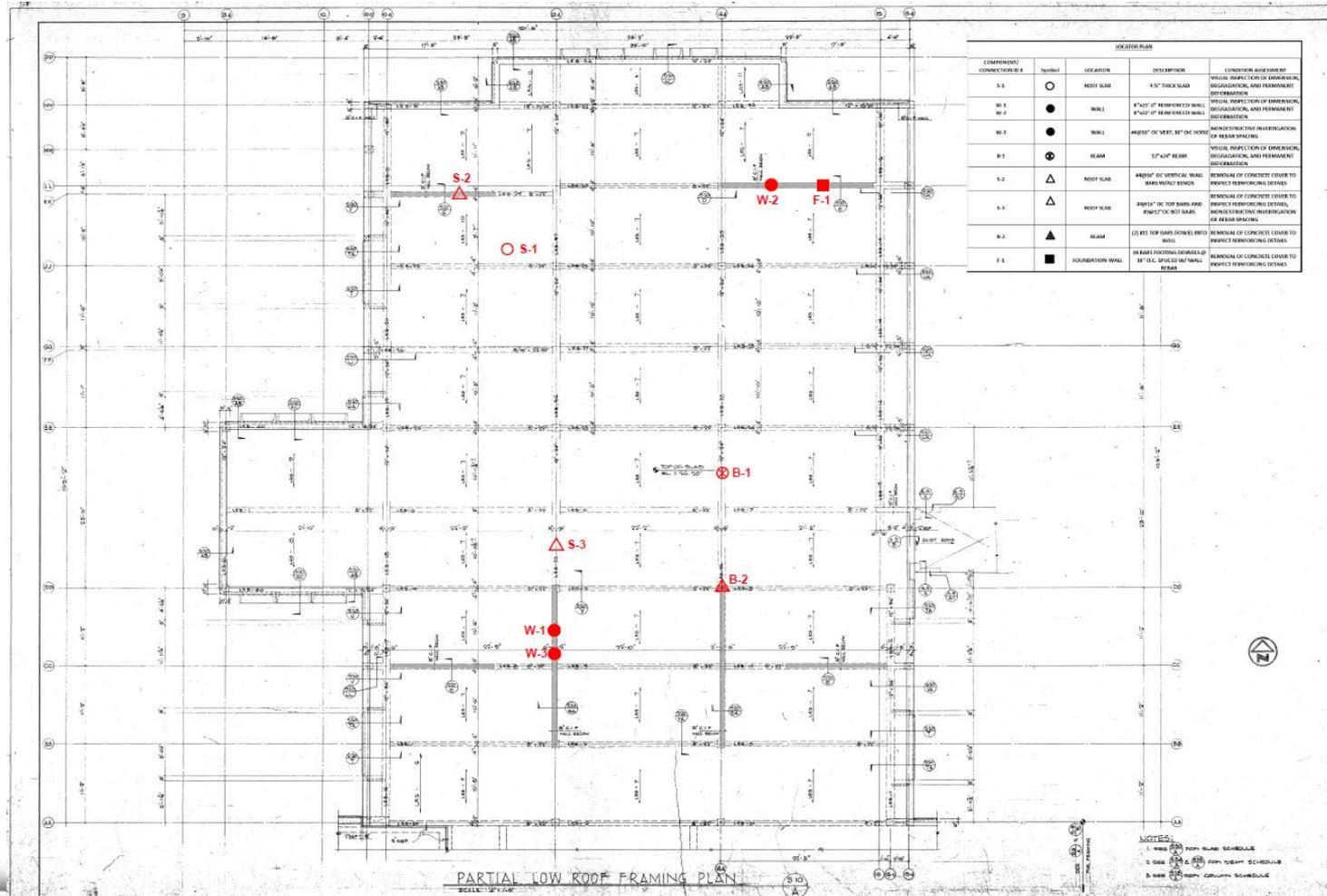


- NOTES:**
1. CONTRACTOR TO LOCATE (E) REINFORCING BY NONDESTRUCTIVE MEANS PRIOR TO REMOVAL OF CONCRETE COVER.
 2. DO NOT CUT OR DAMAGE (E) REINFORCING.
 3. DAMAGED CONCRETE COVER TO BE REPAIRED BY NON SHRINK GROUT W/ MINIMUM COMPRESSIVE STRENGTH OF 5000PSI. ROUGHEN SURFACE AND APPLY BONDING AGENT PRIOR TO GROUT PLACEMENT.

THE GOAL OF THE INVESTIGATION IS TO DETERMINE THE FOUNDATION DOWEL AND WALL REINFORCEMENT LAP SPLICE LENGTH.



CAP Plans



Material Test Program

Table 3-1: Concrete Testing Requirements

Concrete Testing Requirements	Sample	Location	Material	# of Samples	Sample #
<i>Normal Weight Concrete</i>					
Compressive Strength Unit Weight Modulus of Elasticity (*)	4" ϕ core (+)	Roof Slabs	Normal weight concrete (1968, $f'_c = 3000\text{psi}$)	3 Roof Slabs	S-1 to S-3
	4" ϕ core (+)	Shear Walls	Normal weight concrete (1968, $f'_c = 3000\text{psi}$)	3 Walls	W-1 to W-3
	3.75" ϕ core (+)	Slab on Grade	Normal weight concrete $f'_c = 2000$	3 Slab	S-7 to S-9
			TOTAL		

Table 3-2: Reinforcing Steel Testing Requirements

Reinforcing Steel Testing Requirements	Sample	Location	Material	# of Samples	Sample #
Tension Yield Strength	8" gage length	Roof Slabs	Reinforcing steel (1968, ASTM A- 15 Grade 40)	3 Slabs	S-4 to S-6
Tension Ultimate Strength		Shear Walls	Reinforcing steel (1968, ASTM A- 15 Grade 40)	3 Walls	W-4 to W-6
Modulus of Elasticity Chemical Composition and Carbon Equivalent Surface Deformations Elongation					
			TOTAL	6	

(+): The depth-to-diameter ratio of the concrete specimen 2:1 would be preferred. For this reason, the concrete speci

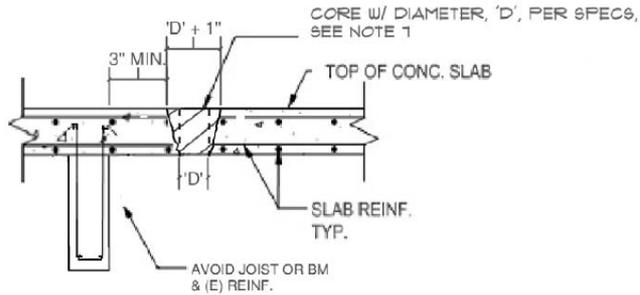
(*): The Modulus of Elasticity should be calculated per ACI 3

1. Perform nondestructive verifications by the observations of grade stamps and conditions. Mechanical properties shall be determined per Section 2.8 of this document.

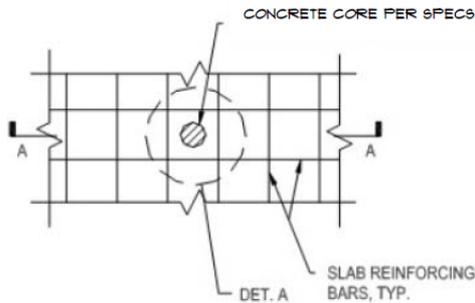
Material Test Program

Applicable Details (App. D)		Sample Type												
		Element	Concrete Cores / Reinforcing Bars			Masonry Prisms / Reinforcing Bars			Steel Coupons ¹					
Repair	Extraction	Slabs	Piles ³	Grade Beams / Pile Caps	Walls	Columns ³	Concrete Gravity Beams ³	Concrete Ring Beams	Walls	Beams	Columns	Welds	Deck	
Foundation		3 / 3	-	3 ² / 3 ²	3 / 3	NA	NA	NA	1 / 1	NA	NA	NA	NA	
Mezzanine		3 / 3	NA	NA	NA	-	-	NA	2 / 2	3	3	3	3	
Roof		3 / 3	NA	NA	3 / 3	-	-	3 / 3	NA	NA	NA	NA	NA	
Repair	Extraction	S1, S4 (Sim)	-	S5	S2 / S3	-	-	Sim. to: S2 / S3	S6	S7, S8, S9	S7, S8, S9	S10	S7, S8, S9	
Sim. to: S2 / S3, S4		-						S6	S7, S8, S9	S7, S8, S9	S10	S7, S8, S9		

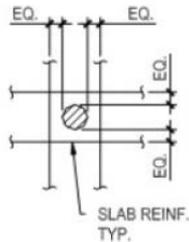
MT Details



SECTION A-A



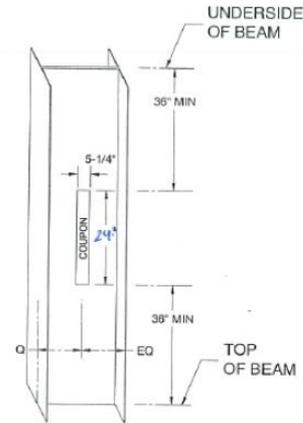
PLAN @ DECK CORE



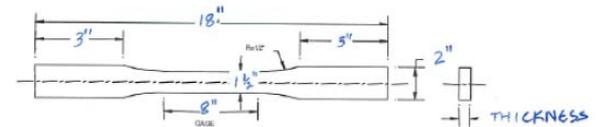
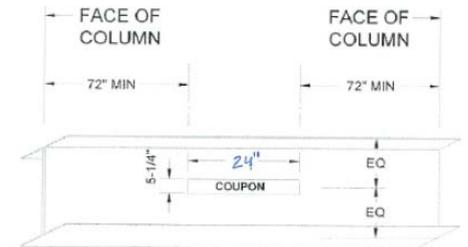
DETAIL A

NOTE:

1. LOCATE JOISTS & BEAMS PRIOR TO REMOVING CONC. CORE SAMPLE.
2. LOCATE ALL JOIST AND SLAB REINFORCING PRIOR TO REMOVING CONC. CORE SAMPLE.
3. DO NOT DAMAGE OR CUT (E) SLAB REINFORCING, POSITION CORE IN CENTER OF REINFORCEMENT GRID WITH EQUAL SPACING ALL AROUND CORE.
4. DO NOT CORE AT JOIST/BEAM LOCATIONS
5. FOR REPAIR, FILL VOID W/ NON-SHRINK GROUT PER SPEC. FINISH SURFACE FLUSH W/ ORIGINAL SURFACE OF SLAB.
6. CONCRETE CORES AT SLAB ON GRADE SIM.
7. OPENING TO BE ENLARGED VIA CHIPPING AS SHOWN PRIOR TO PLACING GROUT PATCH.



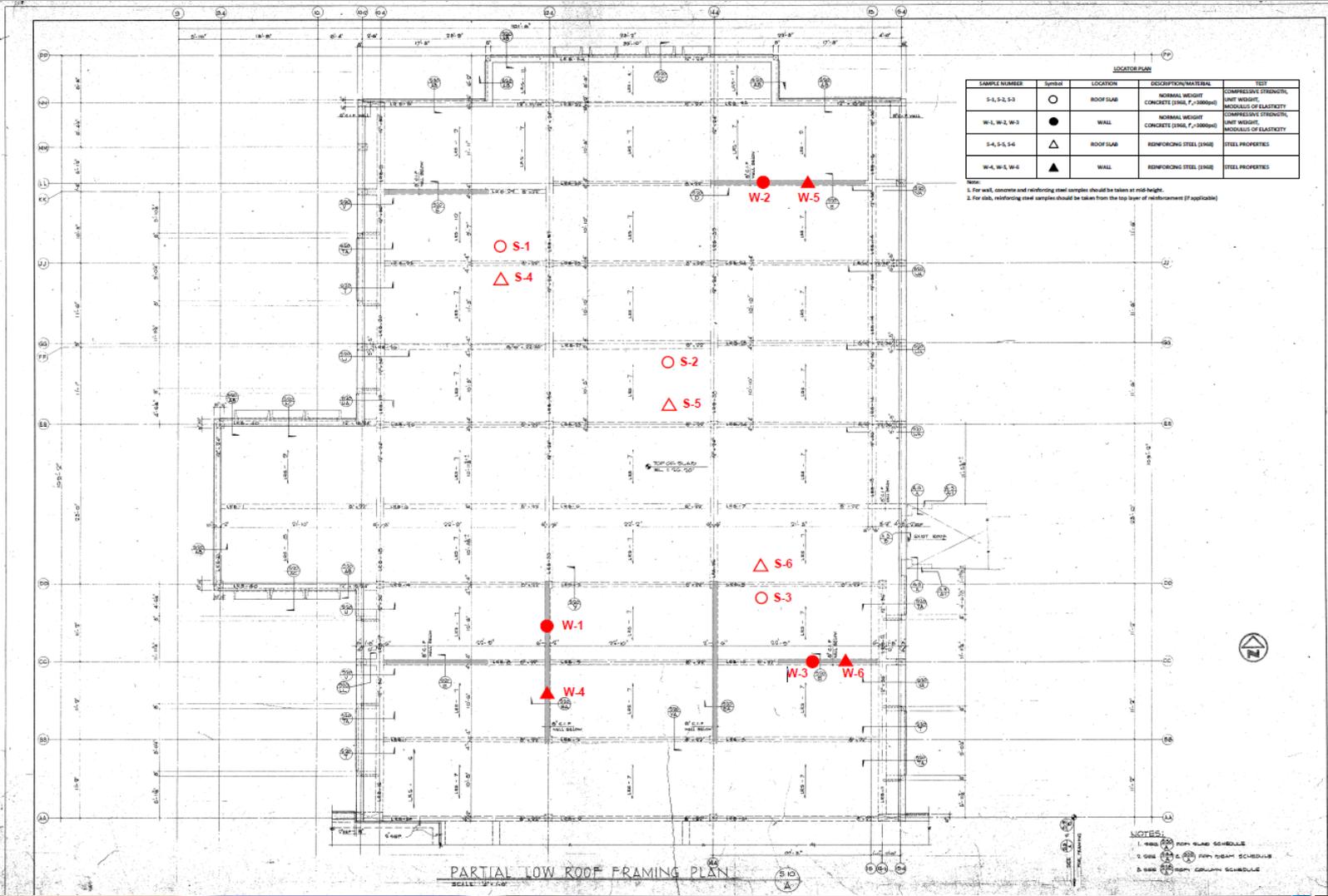
TRIM COUPON TO:



NOTES:

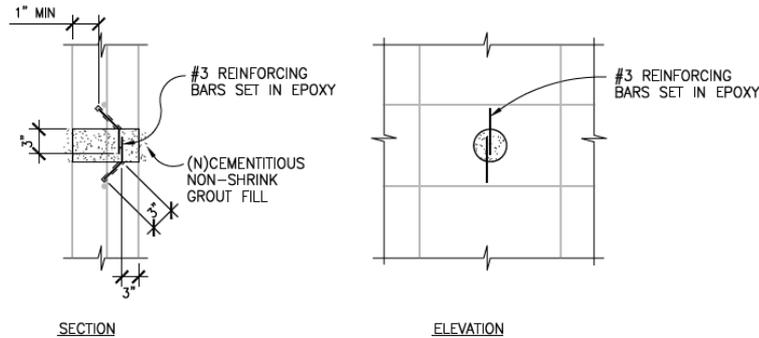
- 1- ASTM A370-02 PROCEDURES SHALL BE EMPLOYED FOR SAMPLING AND TESTING OF THE STEEL COUPONS.
- 2- TRIM COUPONS EQUALLY FROM EA. SIDE TO REMOVE HEAT AFFECTED REGIONS OF STEEL
- 3- COLUMN COUPONS SHALL BE TAKEN A MINIMUM OF 3'-0" FROM ADJACENT TOP OR BOTTOM BEAM CONNECTION.

MT Plans



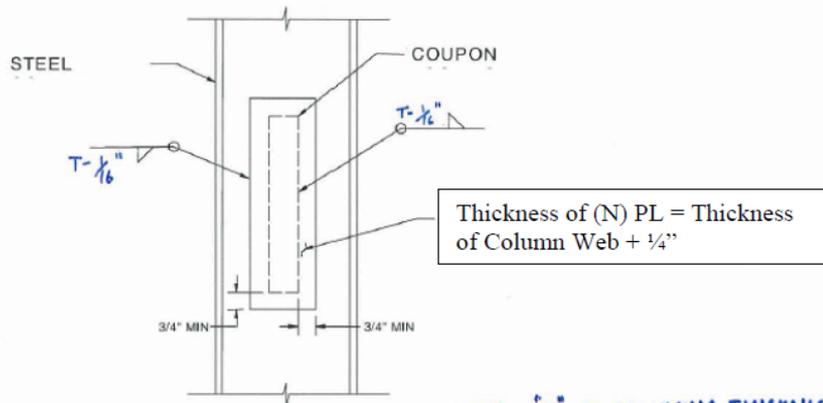
MT Repair Details

NEW DETAIL FOR REPAIR (WALL)

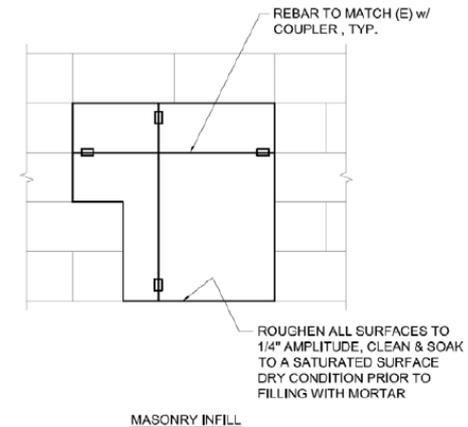
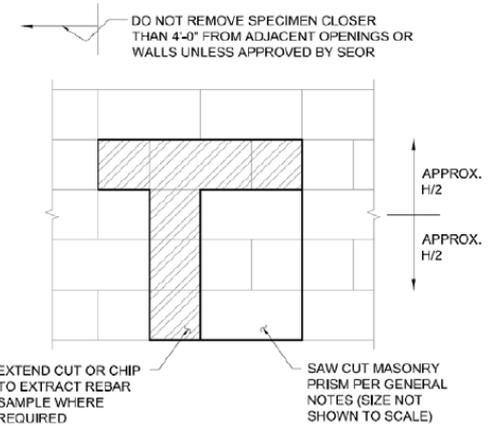


NOTE:
CONTRACTOR TO LOCATE
& AVOID CUTTING (E)
REINFORCING STEEL OR
WELDED WIRE FABRIC
PRIOR TO CORING.

COLUMN PATCH (Similar for Beams):



NOTE: "T" IS MINIMUM THICKNESS
OF JOINING MEMBERS



NOTES:

1. REPOINT SAWCUT OVERCUT.
2. FORM VOID SURFACE AND FILL WITH EMACO S66 CI STRUCTURAL REPAIR MORTAR.
3. CHIP OUT EXCESS, TO BE FLUSH WITH WALL AND PAINT TO MATCH (E) CONDITIONS.
4. REPOINT AFFECTED AREAS W/ ASTM C270 MORTAR.
5. "H" IS THE HEIGHT OF WALL FROM TOP OF FLOOR BELOW TO BOTTOM OF ROOF ABOVE, UNLESS APPROVED BY SEOR.

Excessive Sampling

- For multi-story (4+) and very large plan area buildings (> 200,000 sq. ft), ASCE 41-13 sampling requirements can get onerous.
- If sampling numbers are large – divide into two phases, do 50(X)% sampling and testing first, to give a statistical representation. If all acceptance criteria met (standard deviation), remaining 50(Y)% does not need to be performed.
- Wait-and-see on what is the threshold of “excessive”. Evaluated on a case by case basis.

Questions?

Thank You!