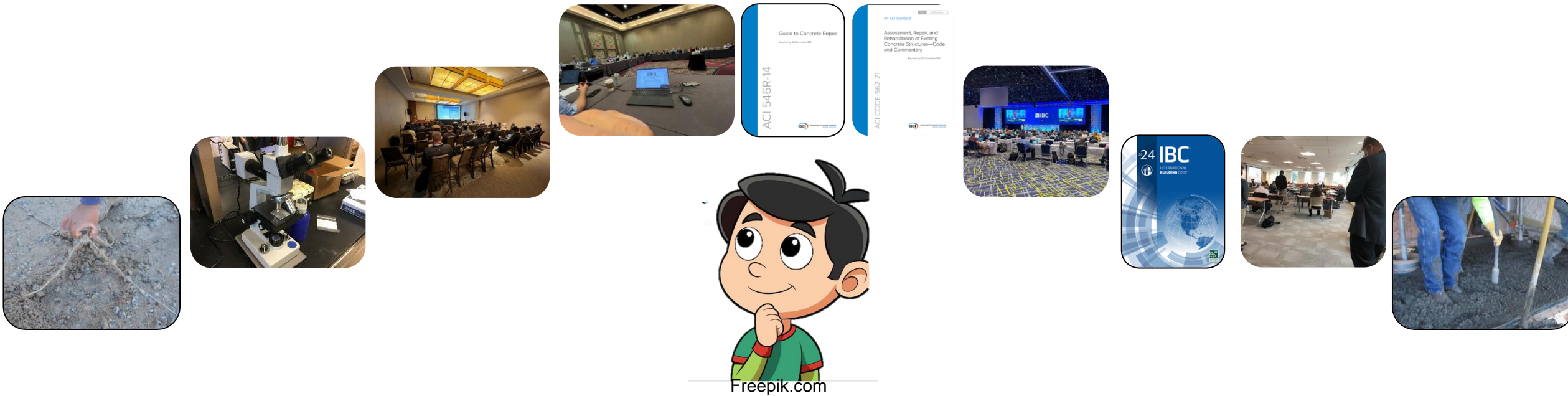


Evolution of an Idea to a Regulation



David G. Tepke, PE, FACI, SKA Consulting Engineers, Inc.

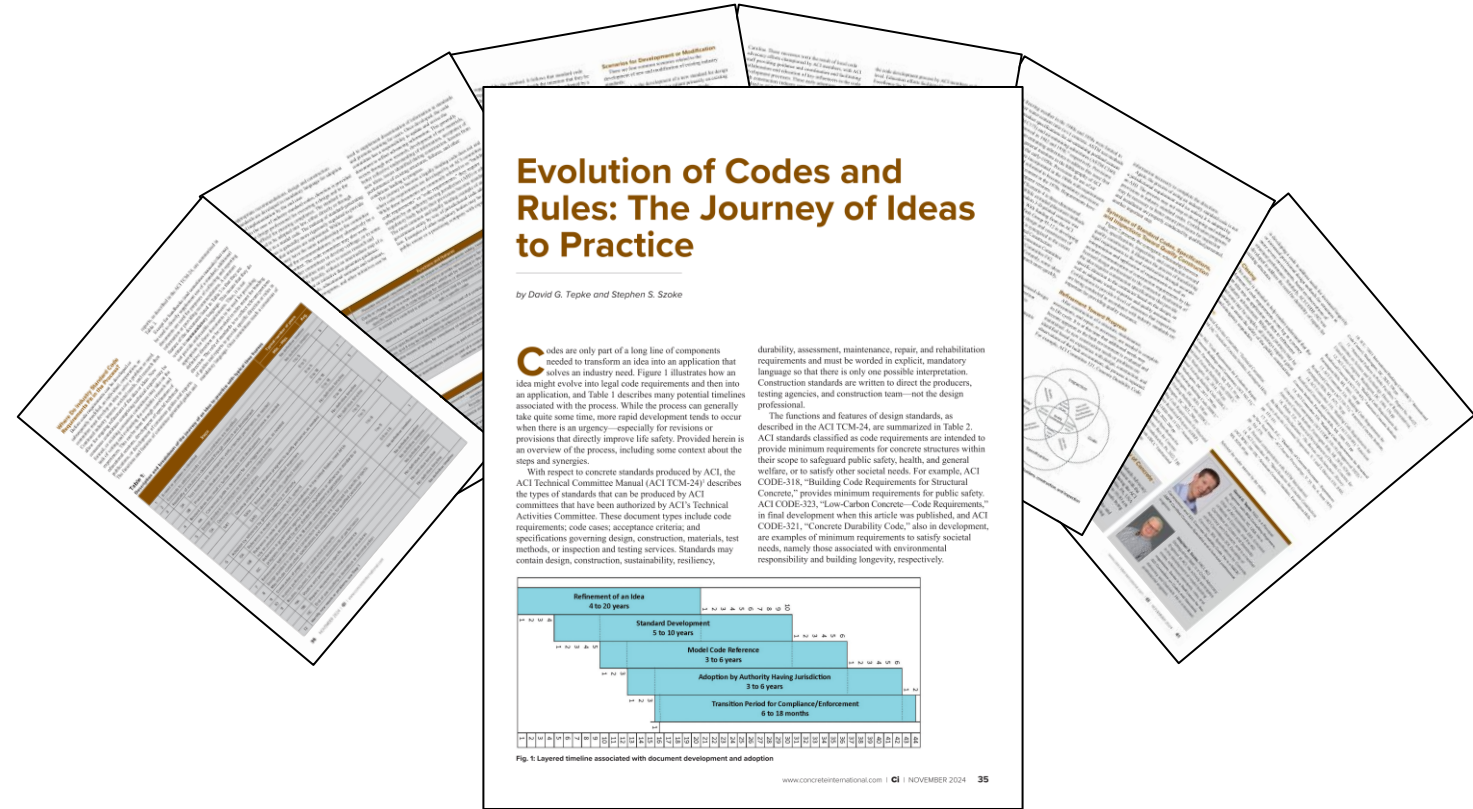
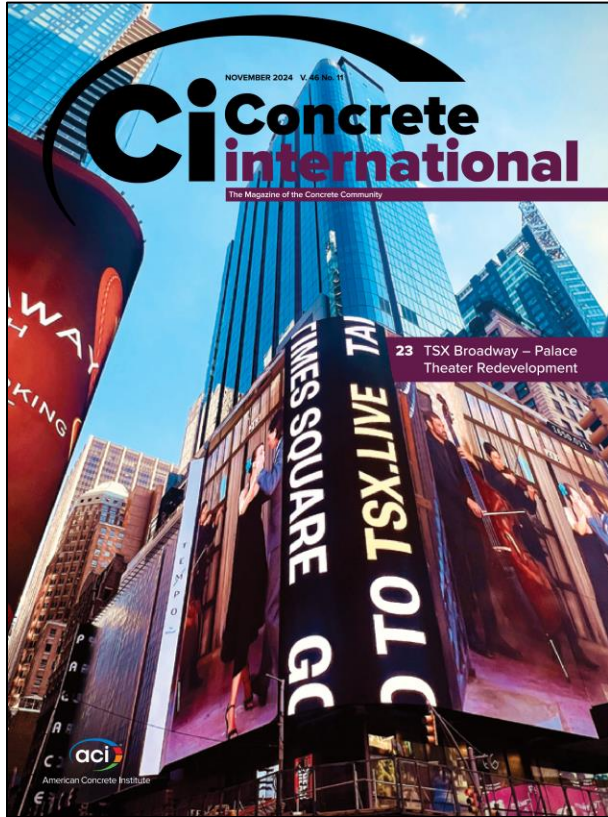
Destiny of Concrete Session | ACI Fall Convention | Philadelphia, PA | Nov. 5, 2024



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Acknowledgements and Additional Information



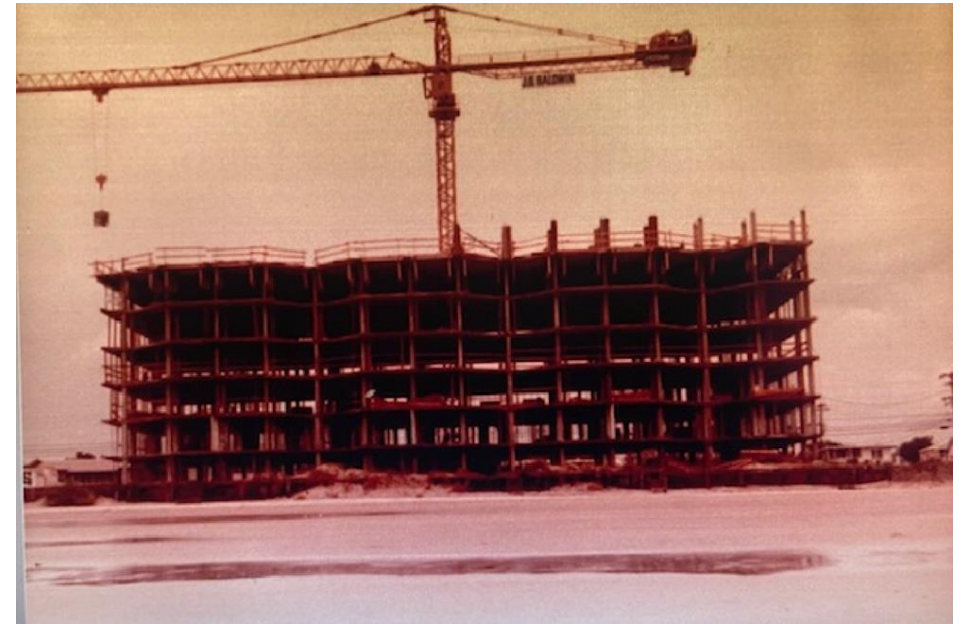
Tepke and Szoke Concrete International | Nov. 2024 (Vol 45, No 11)

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Motivation and Relevance

- Interest when looking at existing structures
- Confirmation of need in talking with others
- General education with increased number of standards and resources



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

 **CONCRETE
CONVENTION**



Opening Comments / Focus

- Regulated / regulatable issues
 - Some technologies for means or non-structural conditions may be different
- ACI process and documents
- Generalized conditions and generalized examples

ACI Standards and Guides (ACI TCM, 2024)

- Guides and Reports

- Provide guidance
- Written in nonmandatory language
- Not for direct integration into contracts



- Standards

- Contain design, construction or other requirements
- Written in explicit, mandatory language
- One possible interpretation
- For direct integration to regulation or contracts



Freepik.com



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

aci CONCRETE
CONVENTION

Guides

- Provide recommendations
- Handbooks and Manuals
 - guidance on how to apply design standards in practice (Handbook)
 - guidance and instructions to field personnel (Manual)
- TechNotes
 - Narrowly focused guides
 - Answers single question

Reports

- Information on concrete technology
- May or may not provide recommendations
- Emerging Technology Report
 - where there is insufficient knowledge to write a comprehensive ACI report

ACI Standards (TCM, 2024)

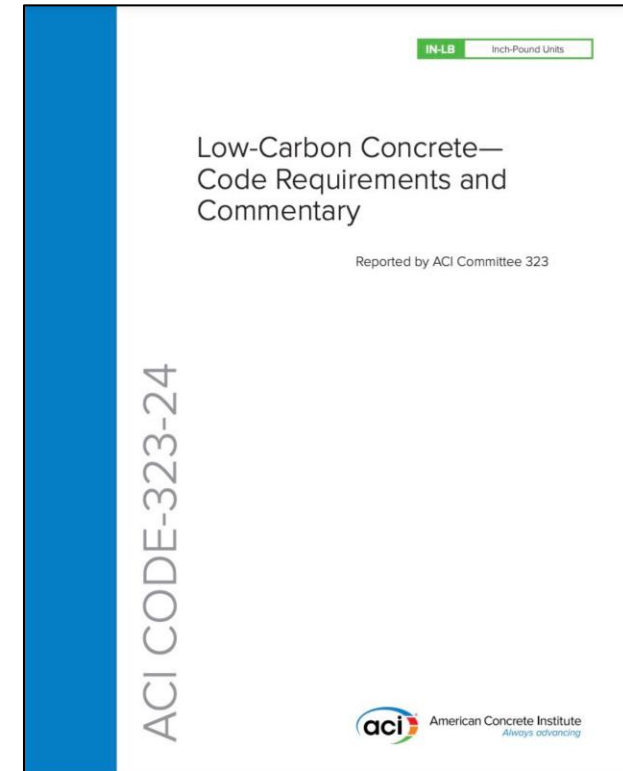
- Code
 - Minimum requirements to safeguard public safety, health, general welfare, or satisfy societal need
- Code Case
- Acceptance Criteria Document
- Material Specification
- Construction Specification
 - Reference standard that can be used as part of contract between Contractor and Owner
- Test Method
- Inspection Services Specification
- Testing Service Specification

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Examples of ACI standard codes

- CODE 318 - Building Code Requirements for Structural Concrete
- CODE 562 - Concrete Repair Code
- CODE 440.11 – GFRP Reinforced Concrete Code
- **CODE 323 - Low-Carbon Concrete Code**
- CODE 321 – Concrete Durability Code
– Expected 2027



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Difference between a Code... a Code... and a Code...



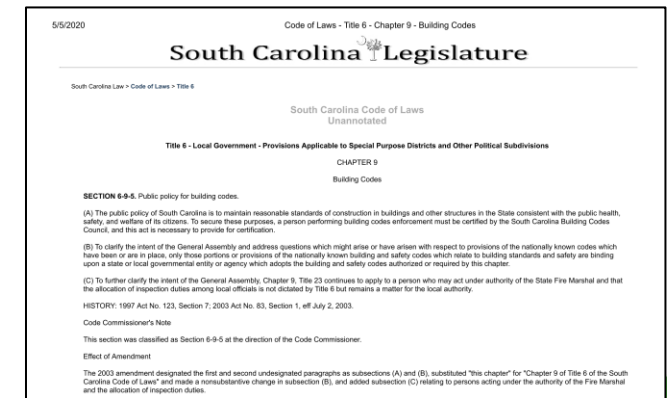
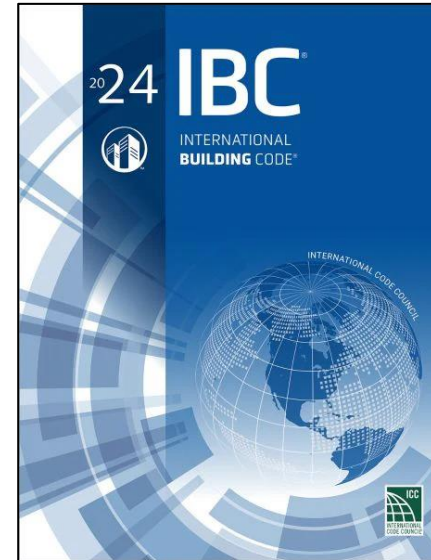
<https://www.flickr.com/>

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Difference between a Code... a Code... and a Code...

- Industry Standard Code
 - Such As CODE 318
- Model Code
 - Such as ICC International Building Code
- Jurisdictional Code or Regulation
 - Authority Having Jurisdiction (AHJ)
 - Such as State regulation using unique language, referencing an industry standard code, model code or combination thereof



Examples of ACI standard specifications

- SPEC 301 – Standard Specifications for Concrete Construction
 - Used with ACI CODE 318
- SPEC 563 – Standard Specifications for Concrete Repairs
 - Used with ACI CODE 562
- SPEC 440.5: Construction with Glass Fiber-Reinforced Polymer Reinforcing Bars
 - Used with Code 440.11

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



The Journey from Idea to Regulation

Applicable for

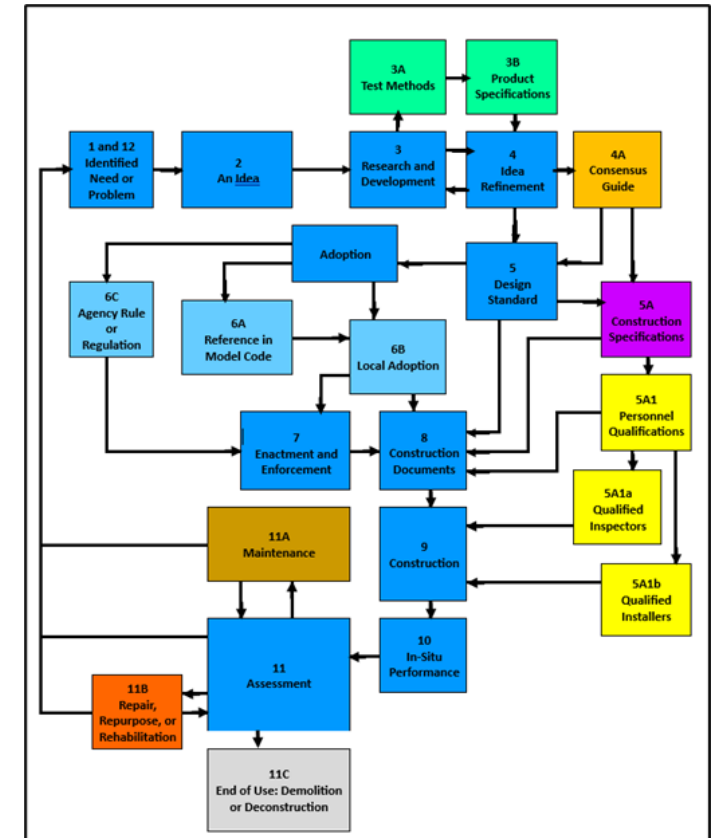
Entire Code Development

or

Provision Development

Steps		Typical number of years		
		Min. – Max.	Avg.	
1	A need or problem is identified	No definitive timeline		
2	Concepts to address needs or resolve problems are identified	No definitive timeline		
3	Feasibility of solutions is determined through research and development	1 to 5	5	
3A	Test methods are developed to verify intended performance, as needed	0 to 5		
3B	Product specifications are developed for minimum performance, as needed	0 to 5		
4	Revised ideas may result in further research and development	0 to 10	7	
4A	Consensus guide is developed for early/aggressive users, as needed	0 to 10		
5	Design standard is developed as minimum code requirements	0 to 10		5
5A	Develop construction specifications	No definitive timeline		
	5A1	Develop criteria and verification programs to qualify personnel, as needed	0 to 10	
		5A1a	Educate and verify qualified inspectors	No definitive timeline
		5A1b	Educate and verify qualified installers	No definitive timeline
6	Adoption by reference by governing agency or authority	1 to 6	5	
6A	Reference in model building code (U.S. system)	1 to 3		
6B	Reference in code of authority having jurisdiction. In the United States, most AHJs rely on provisions accepted in model building codes	1 to 6		
6C	Reference in government agency rules and regulations or reference in standards or programs maintained by other standard development organizations	1 to 5		
7	Enforcement typically follows a 6 to 18 month waiting/learning period	0.5 to 1.5	1	
8	Design standard is used, and construction documents are developed for specific projects. May include construction specifications and requirements for qualified personnel	No definitive timeline		
9	Construction of project	No definitive timeline		
10	In-place performance of constructed elements	No definitive timeline		
11	Routine, required, or maintenance assessments of performance	No definitive timeline		
11A	Routine and performance-specific maintenance	No definitive timeline		
11B	Repairs, repurposing, or rehabilitation of structures	No definitive timeline		
11C	End of use resulting in demolition or deconstruction	No definitive timeline		
12	Identify new needs or problems, see Step 1	No definitive timeline		

Tepke & Szoke, 2024



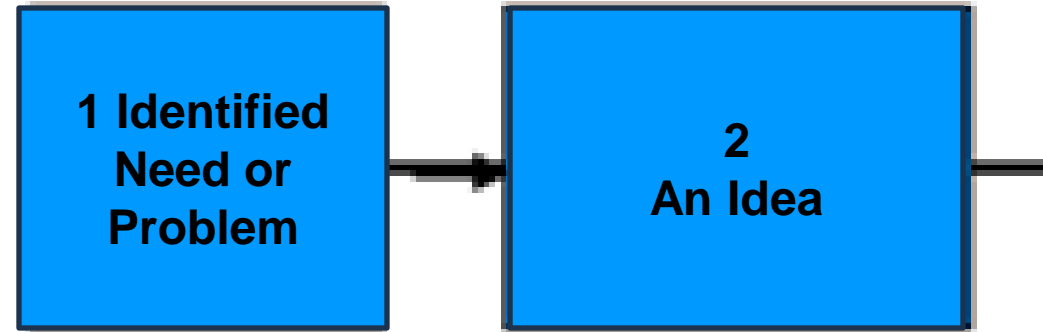
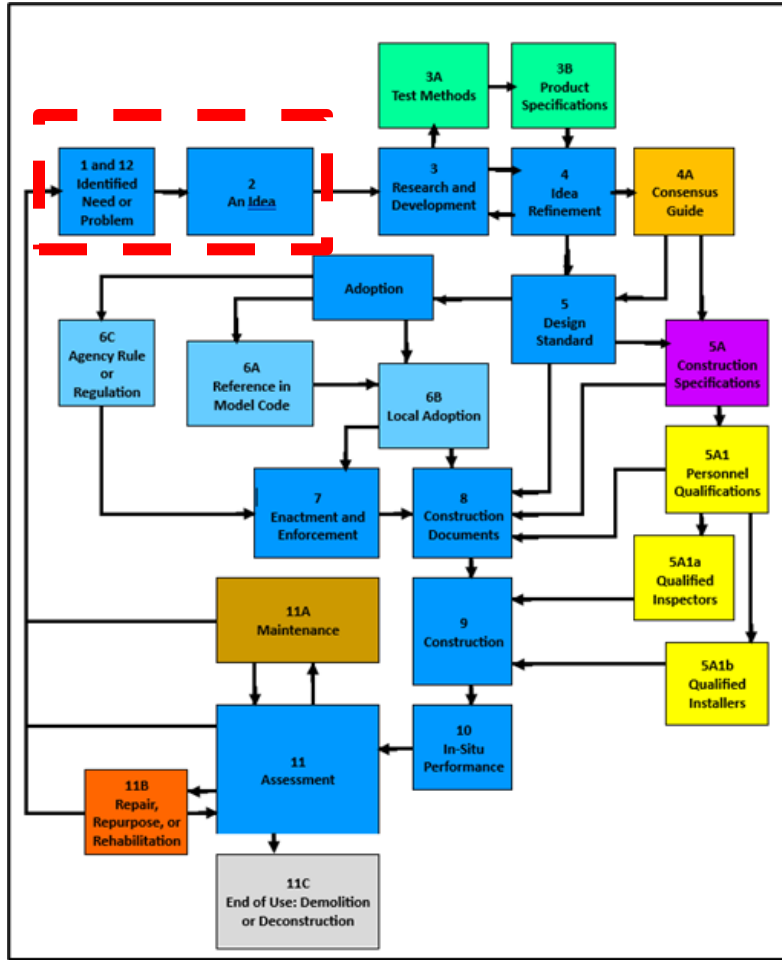
Szoke Rendering, Unpublished



aci CONCRETE CONVENTION

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

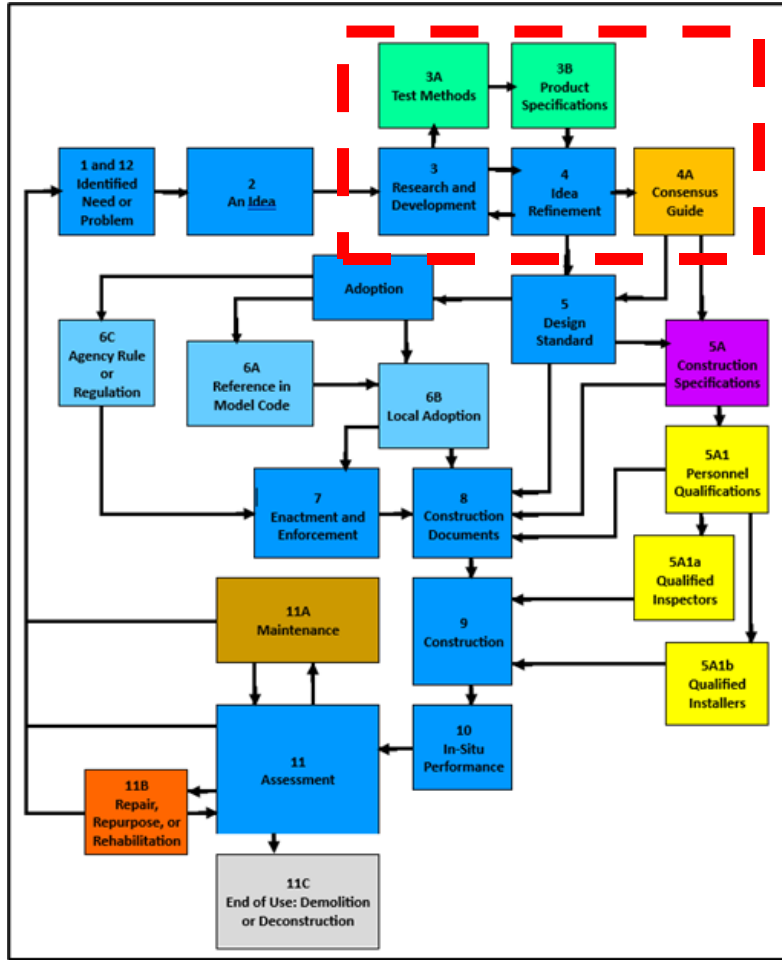
The Idea or Need to Solve a Problem



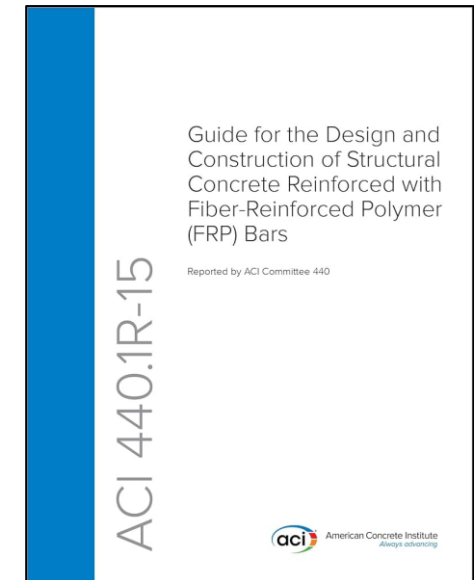
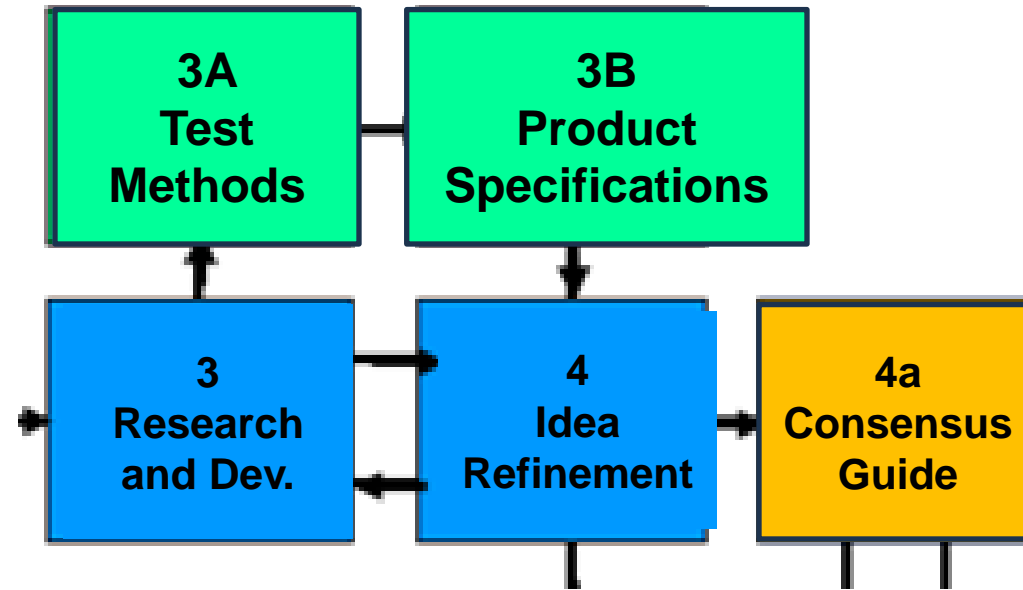
THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

aci CONCRETE CONVENTION

Refinement / Agreement



5 to 15 years or so...

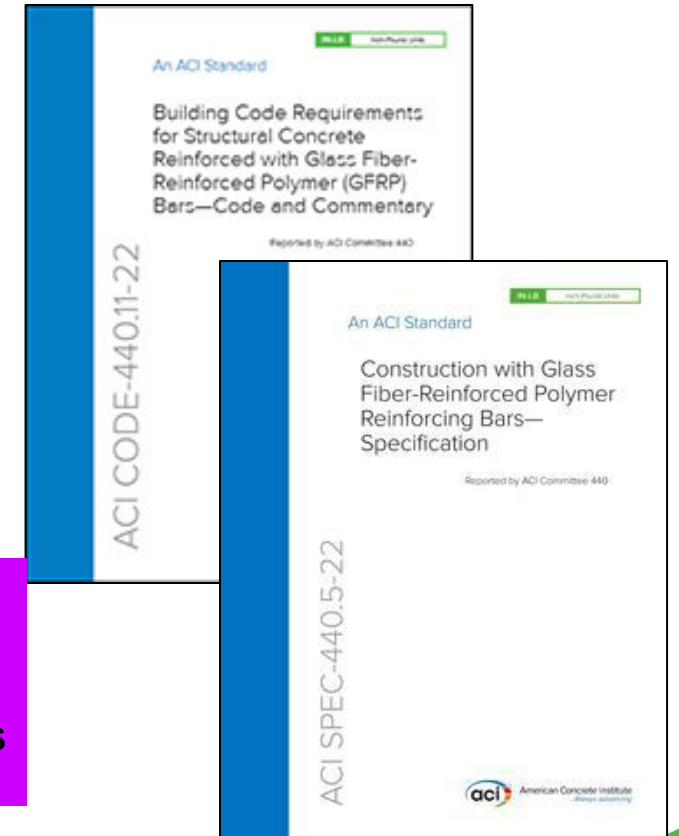
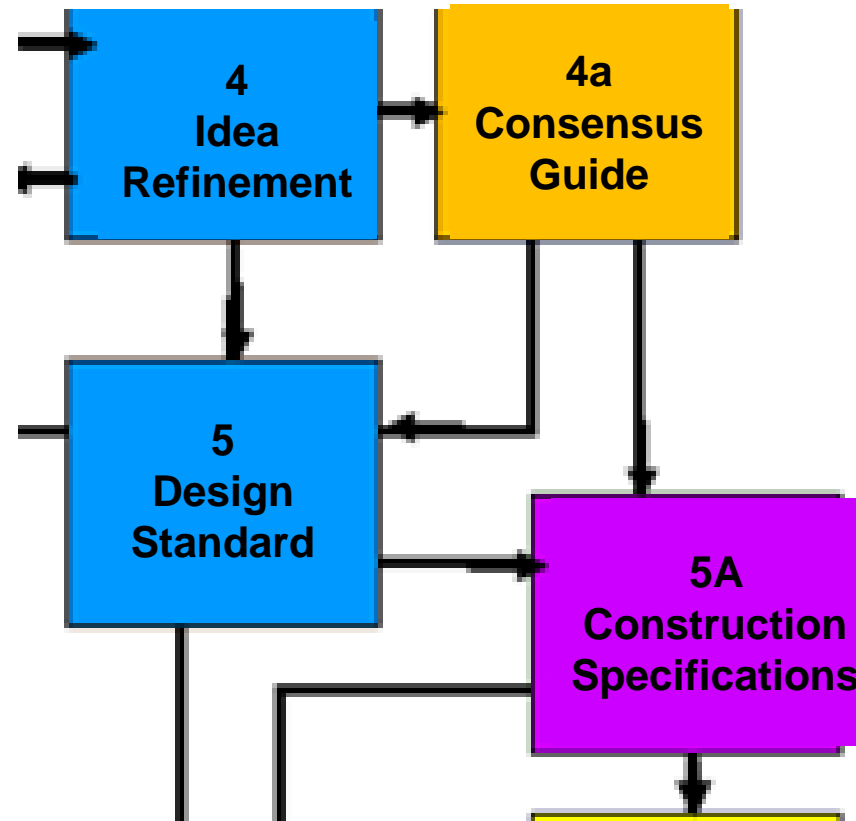
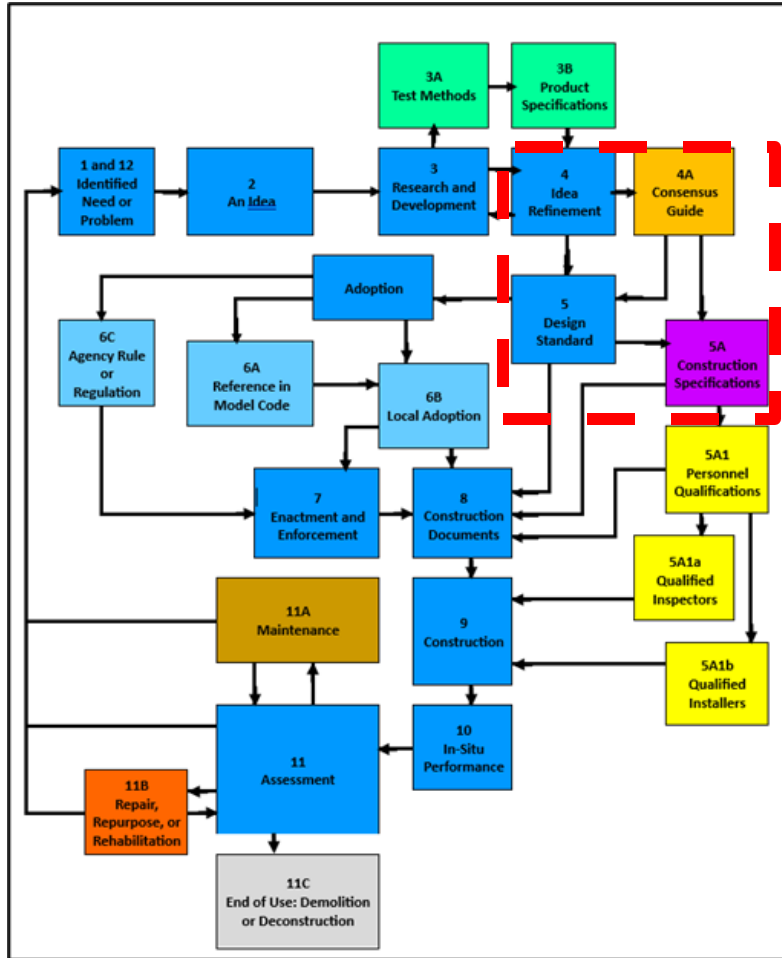


THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Standardization

Standard Code Development: 5 to 10 years or so...
Highly variable
Public Comments



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Historic Example of Standardization without Guides

	ACI Codes			ACI Committee Guides and Reports			
	ACI 318	ACI 350	ACI 562	ACI 201	ACI 222	ACI 350	ACI 564
1900-1910							
	Laws & Ord. (1907)						
1910-1920	NACU Standard No. 4 (1910)						
1920-1930	ACI Standard Specification 23 (1920)						
1930-1940							
	ACI 501-36						

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Historic Example of Standardization without Guides

	ACI Codes			ACI Committee Guides and Reports			
	ACI 318	ACI 350	ACI 562	ACI 201	ACI 222	ACI 350	ACI 564
1950-1960	ACI 318-51						
	ACI 318-56						
1960-1970	ACI 318-63			ACI 201 Report - JACI 59-57 (1962)			
	ACI 318-71 ('73,'74,'75,'76s)						ACI 350 Report JACI 68-50 (1971)
1970-1980	ACI 318-77 ('80s)					ACI 350 Report JACI 74-26 (1977)	
	ACI 318-83 ('86s)			ACI 201.2R-77		ACI 350 Report JACI 80-44 (1983)	
1980-1990	ACI 318-89				ACI 222R-85		



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Historic Example of Standardization without Guides

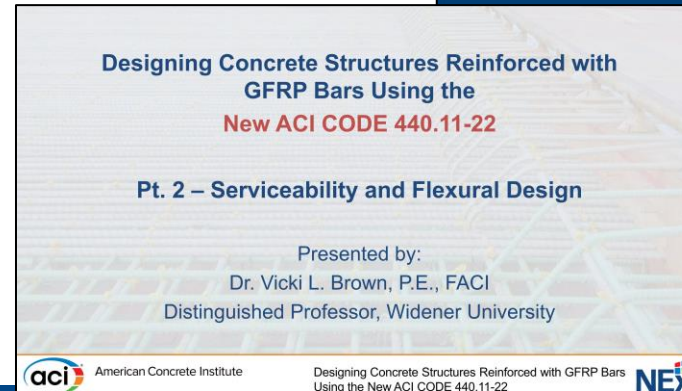
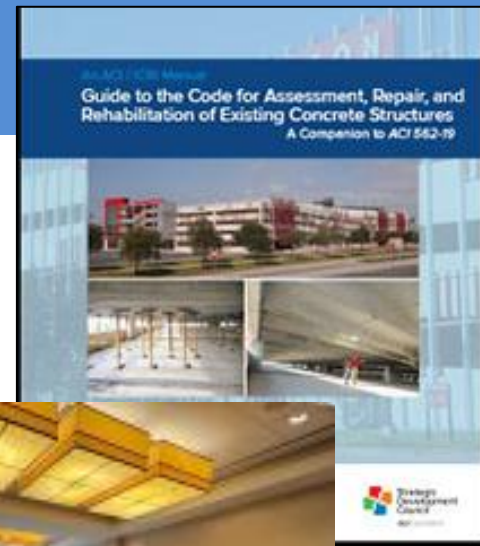
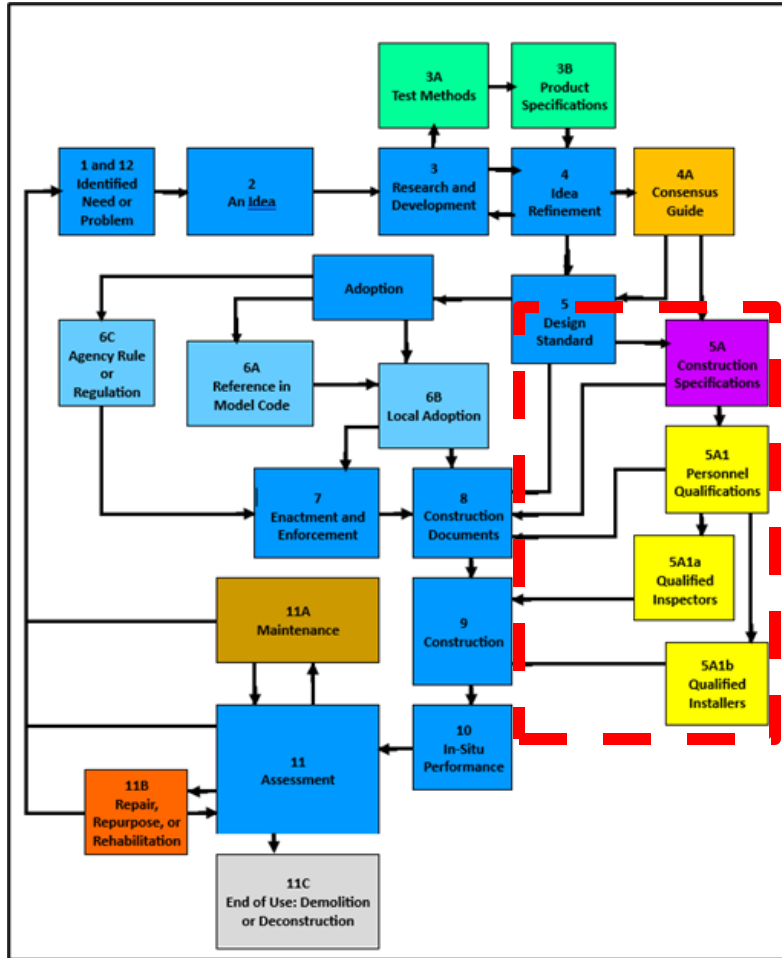
	ACI Codes			ACI Committee Guides and Reports			
	ACI 318	ACI 350	ACI 562	ACI 201	ACI 222	ACI 350	ACI 564
1990-2000	ACI 318-89				ACI 222R-89	ACI 350R-89	
	ACI 318-89 (r92)			ACI 201.2R-92	ACI 222R-96		
	ACI 318-95						ACI 546R-96
2000-2010	ACI 318-99	ACI 350-01		ACI 201.2R-01	ACI 222R-01		ACI 546R-04
	ACI 318-02	ACI 350-06		ACI 201.2R-08			
	ACI 318-05						
2010-2020	ACI 318-08	ACI 350-06	ACI 562-13	ACI 201.2R-16			ACI 546R-14
	ACI 318-11		ACI 562-16				
	ACI 318-14		ACI 562-19				
2020-present	ACI 318-19	ACI 350-20	ACI 562-21		ACI 222R-19		

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Education

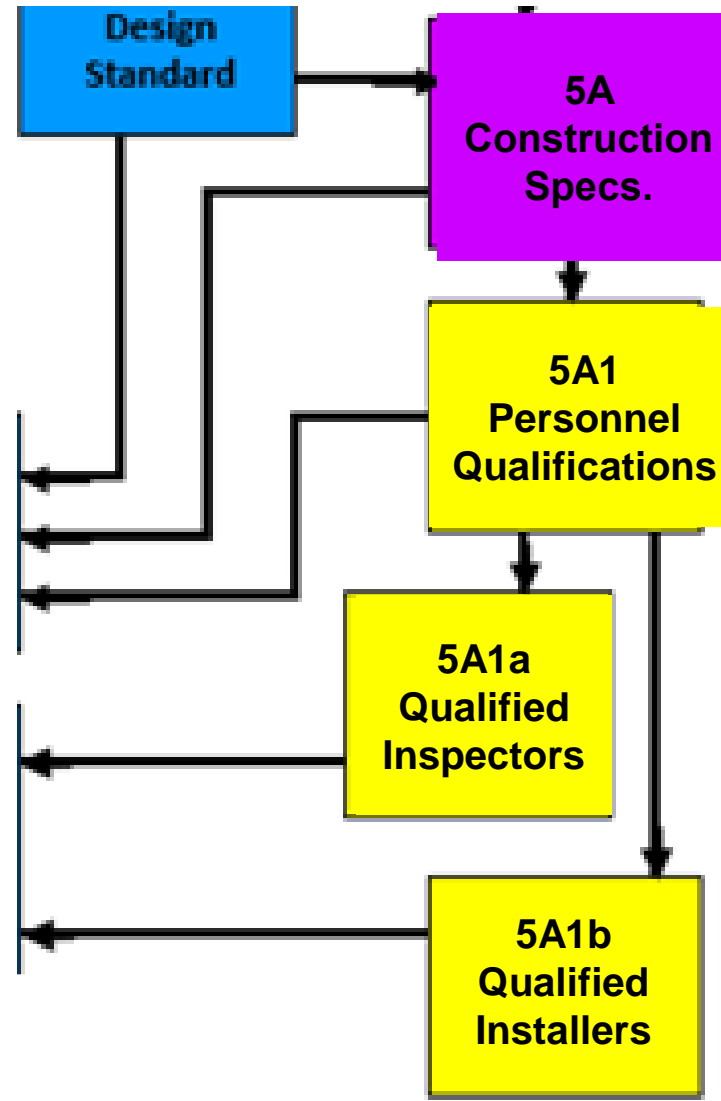
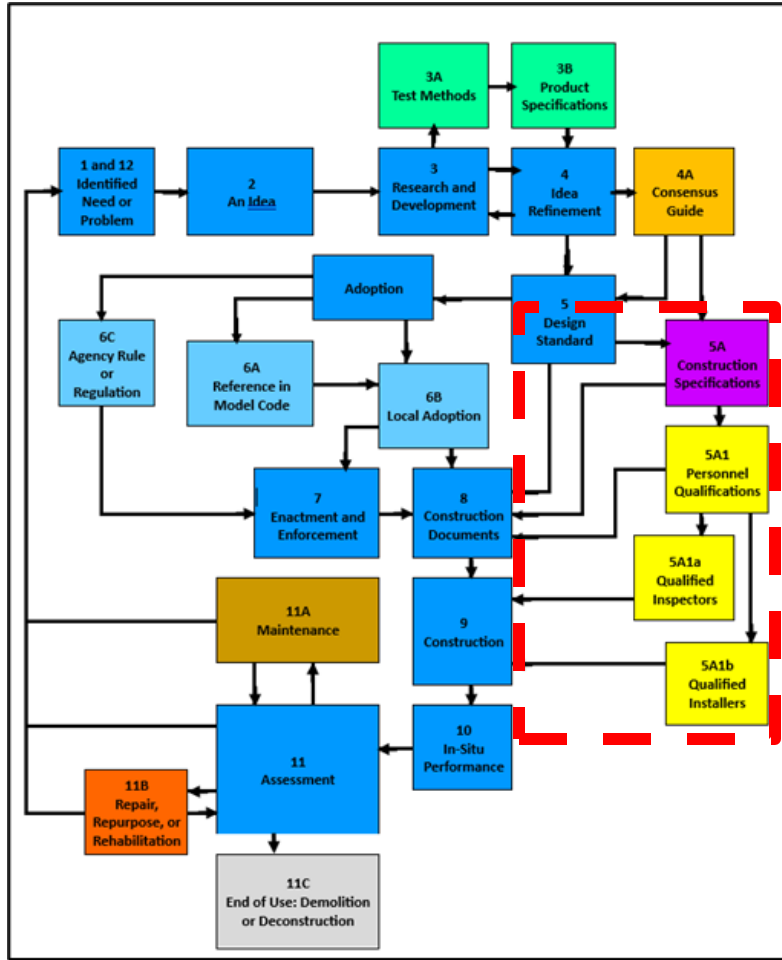
- Engineers
- Code Officials
- Other stakeholders



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Qualification and Certification



Qualification & Certification Programs

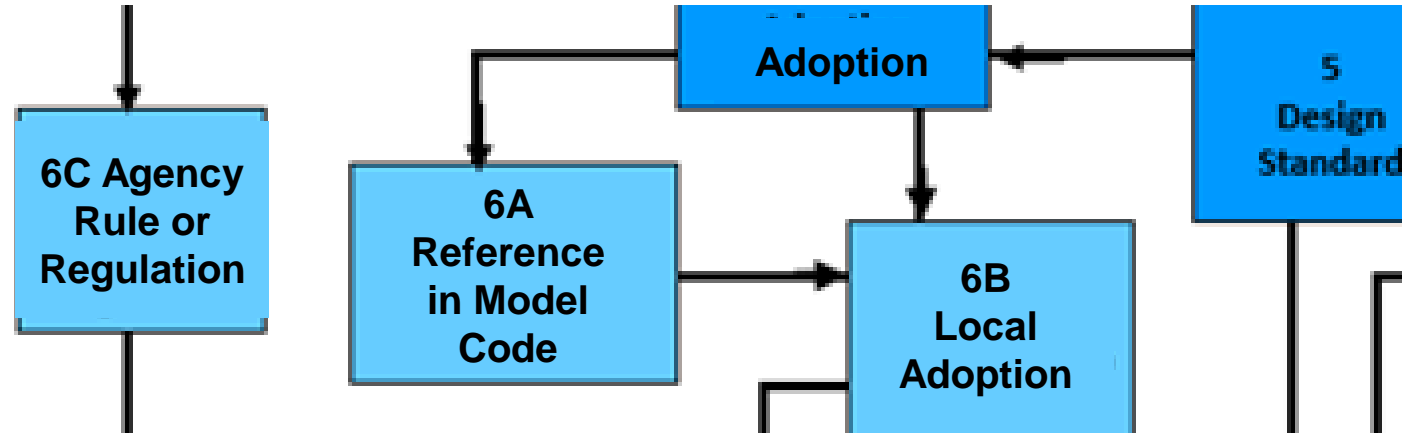
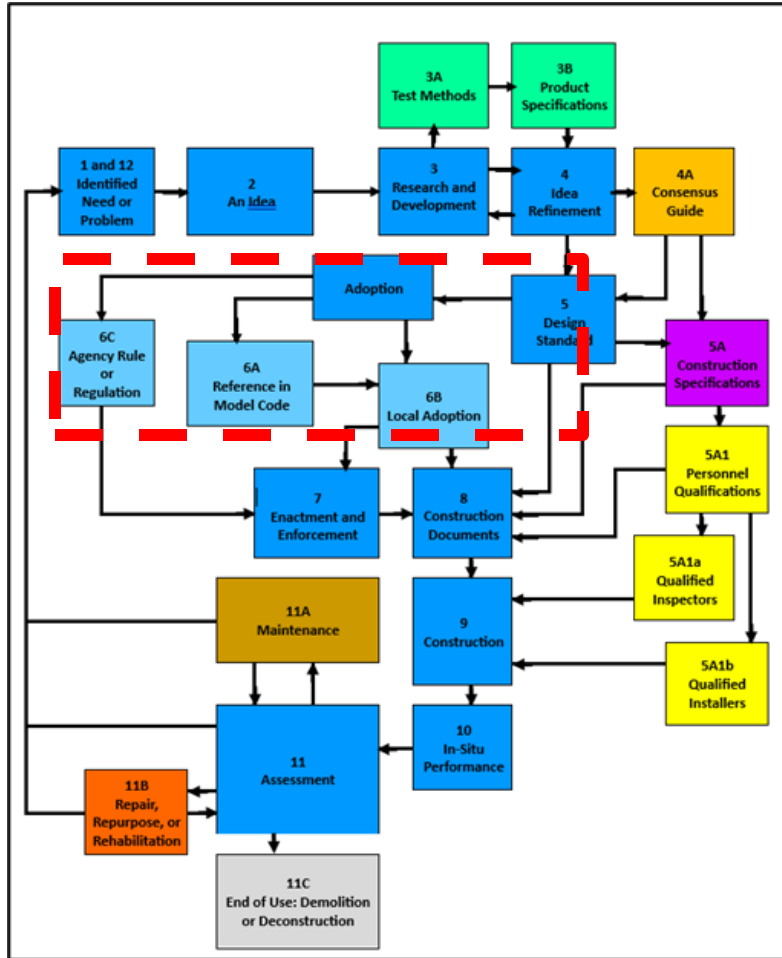


THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

aci CONCRETE CONVENTION

Adoption

Model Code Adoption: 3 to 6 years (variable)
Jurisdictional Adoption: 3 to 6 years (variable)



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

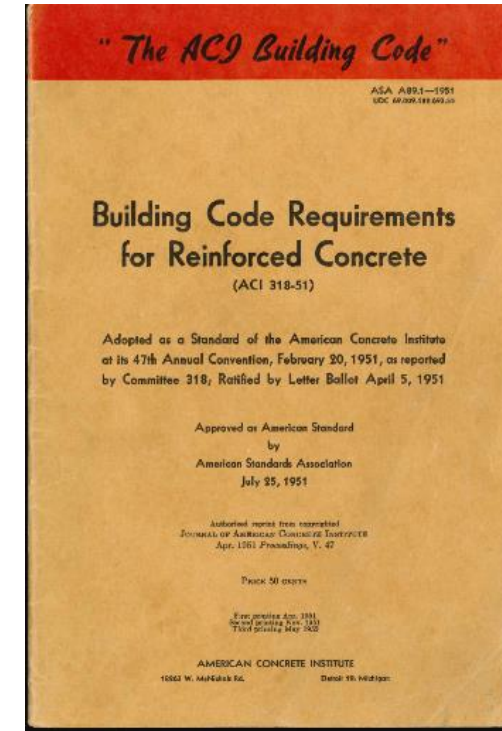
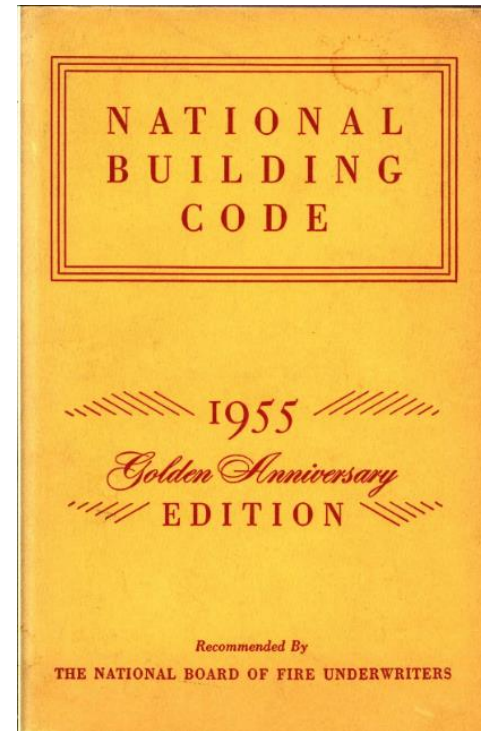
ACI CONCRETE CONVENTION

Historic Example

City of Charleston
Department of Public Service
Inspections Division

Building Code Adoption

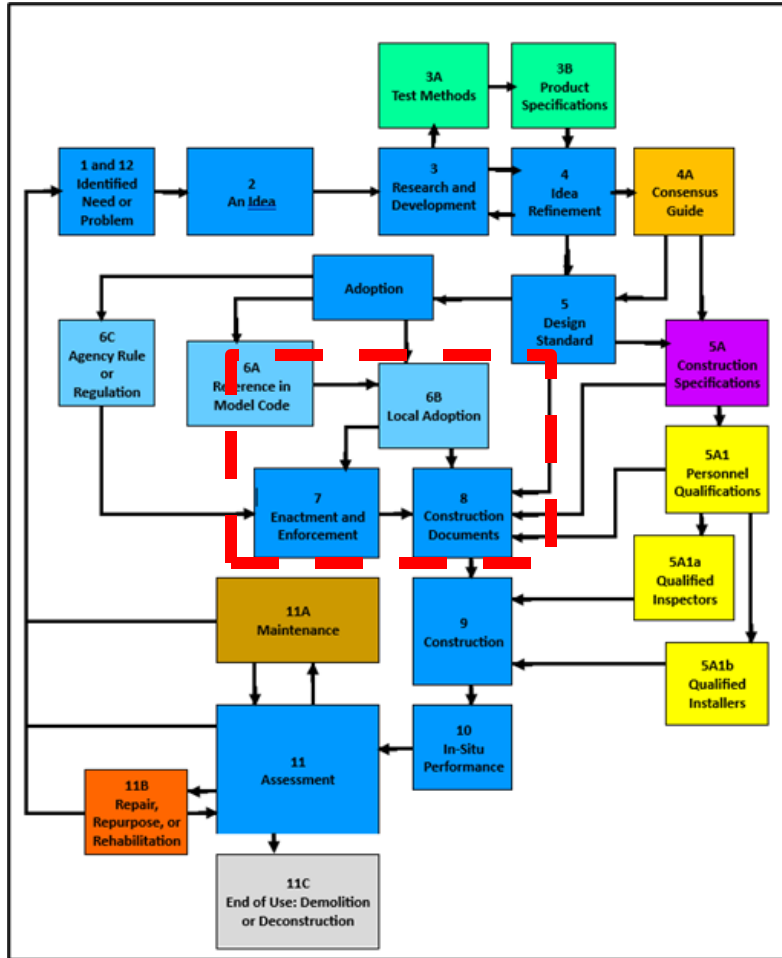
- 1895 Chapter XIII, Section 482 of City Ordinances
- 1929 Section 684 of City Code, National Board of Fire Underwriters, in addition to requirements prescribed by City Ordinance.
- 1952 Section 9-13, Adopted National Building Code, 1949 Edition
- 1964 Section 10-14, Adopted National Building Code, 1955 Edition
- 1975 Section 10-18, Adopted National Building Code, 1967 Edition



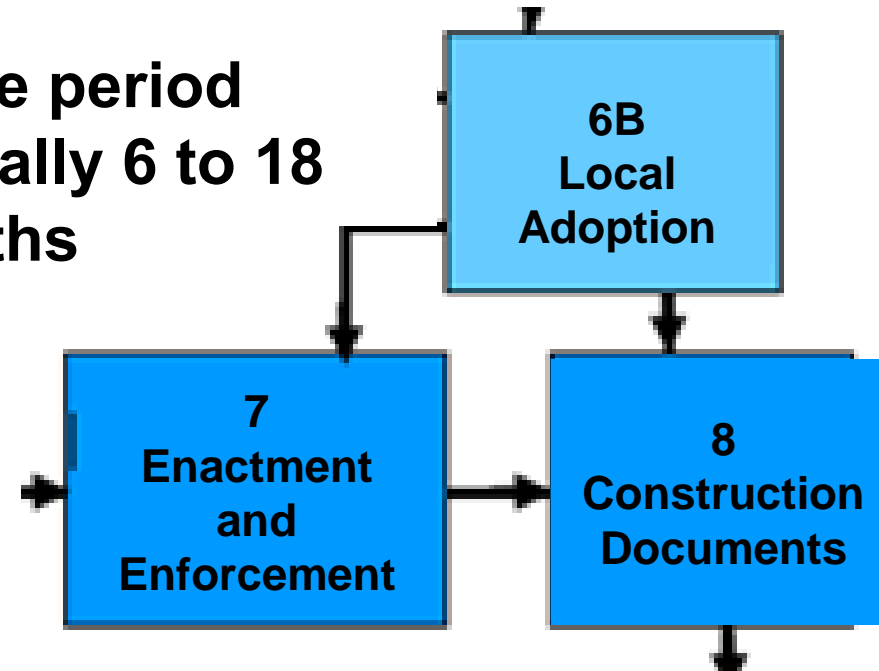
THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Enforcement



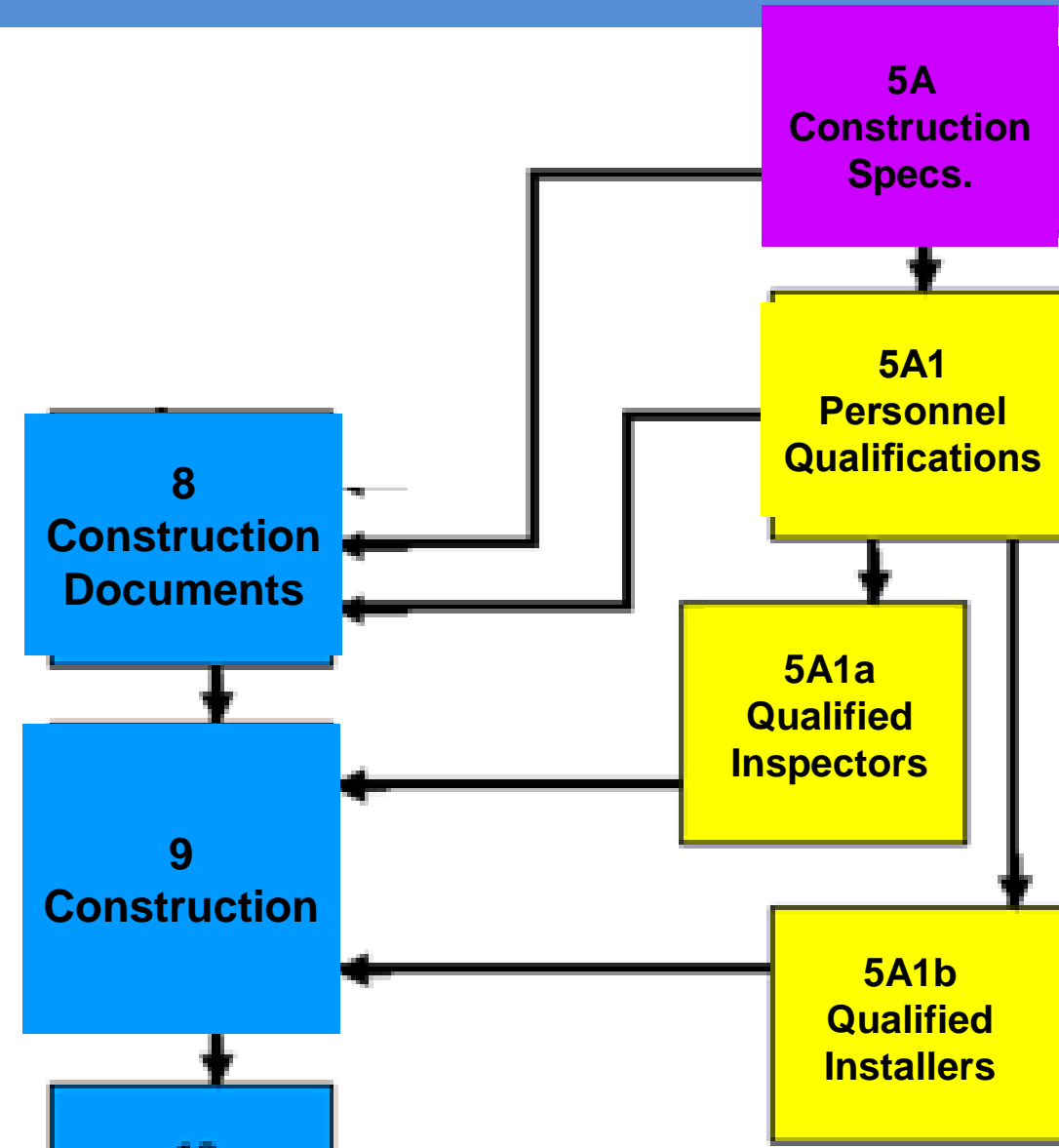
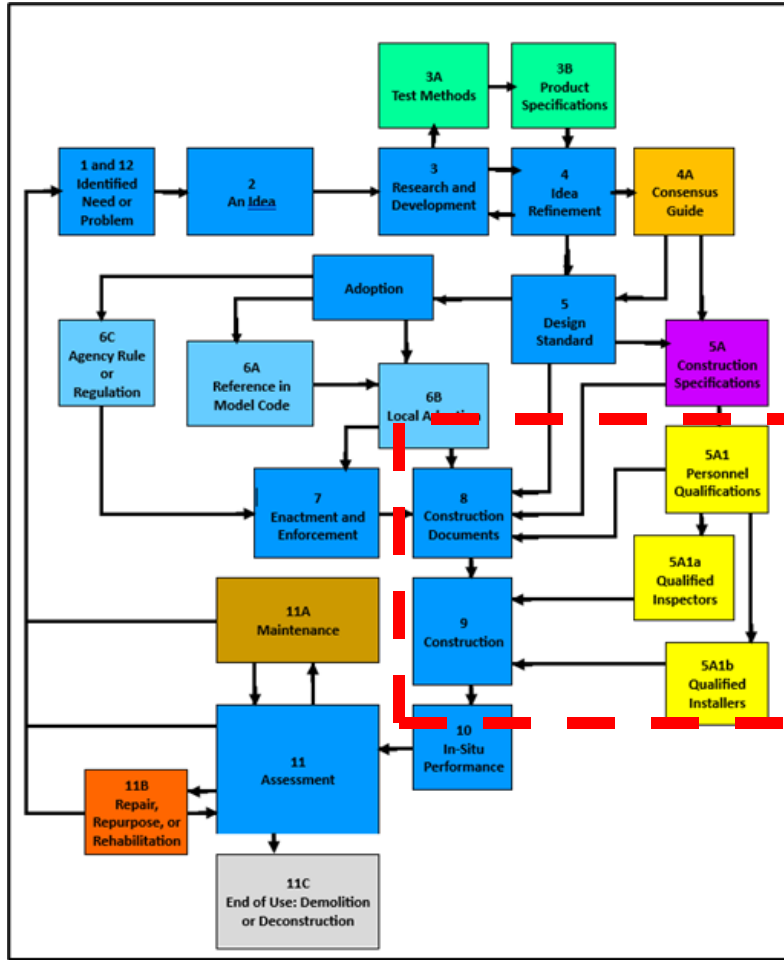
Grace period
typically 6 to 18
months



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

aci CONCRETE
CONVENTION

Construction



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

Code-Based Synergies for Quality Construction

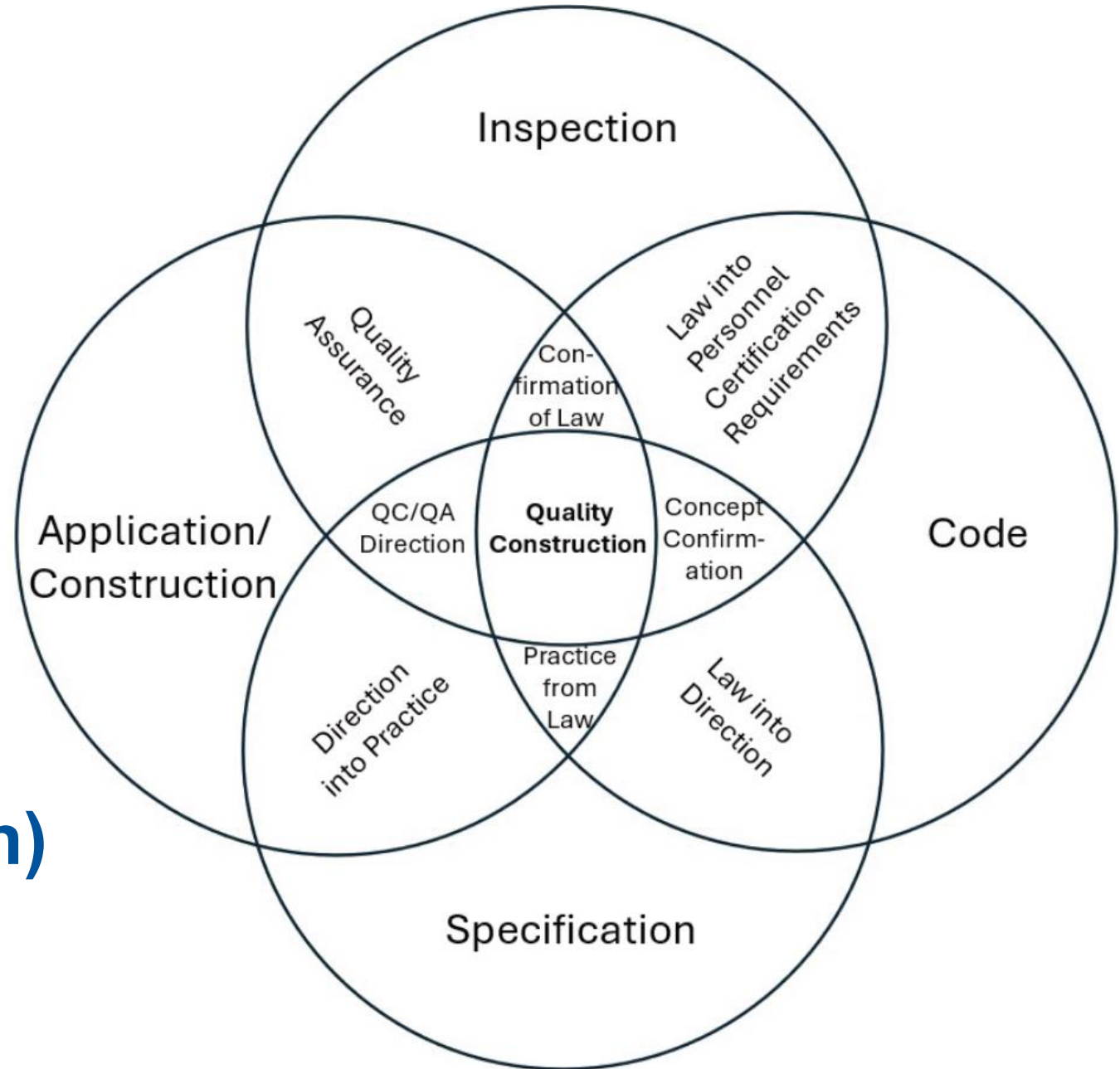
Code (Law)

to

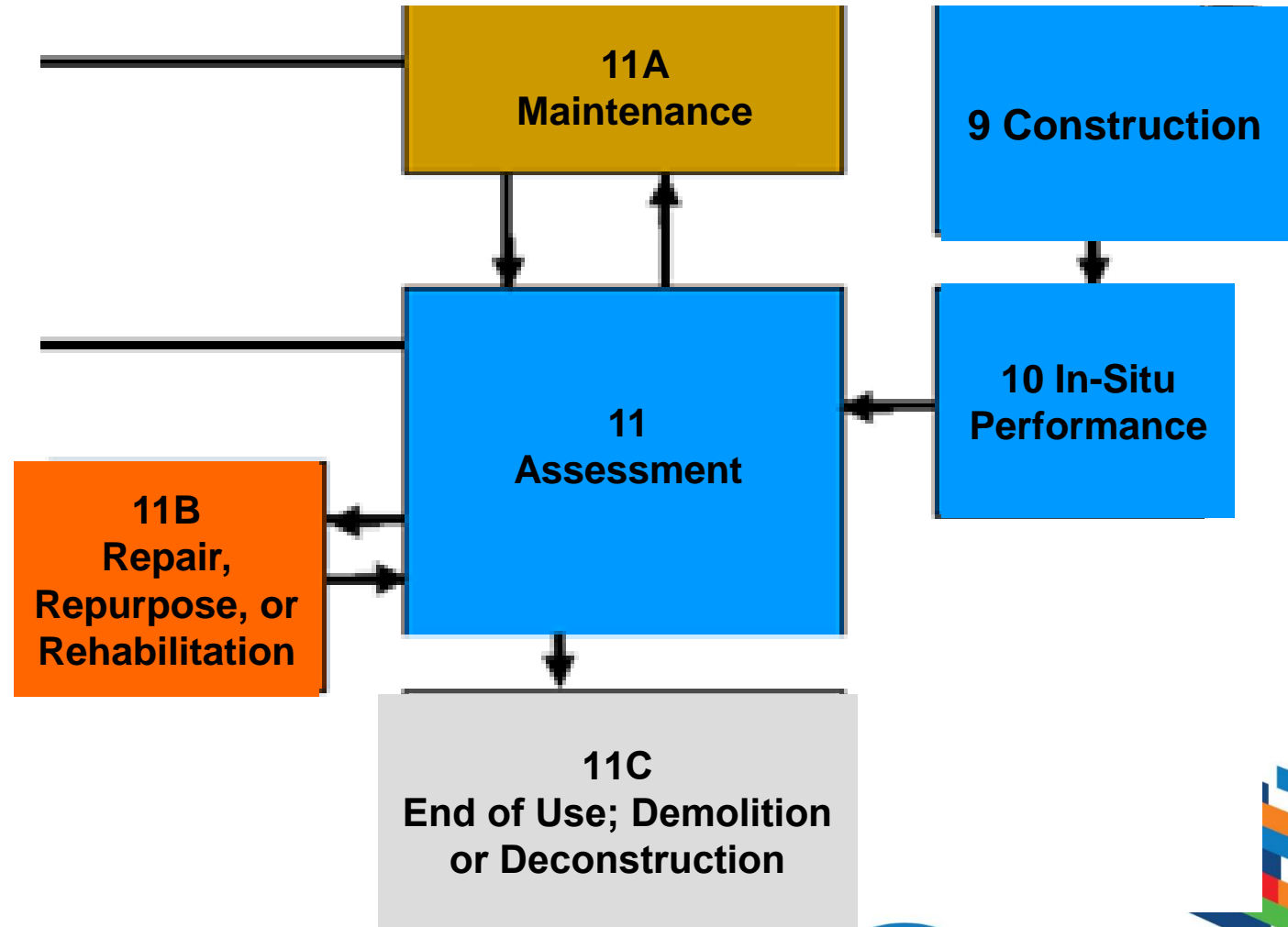
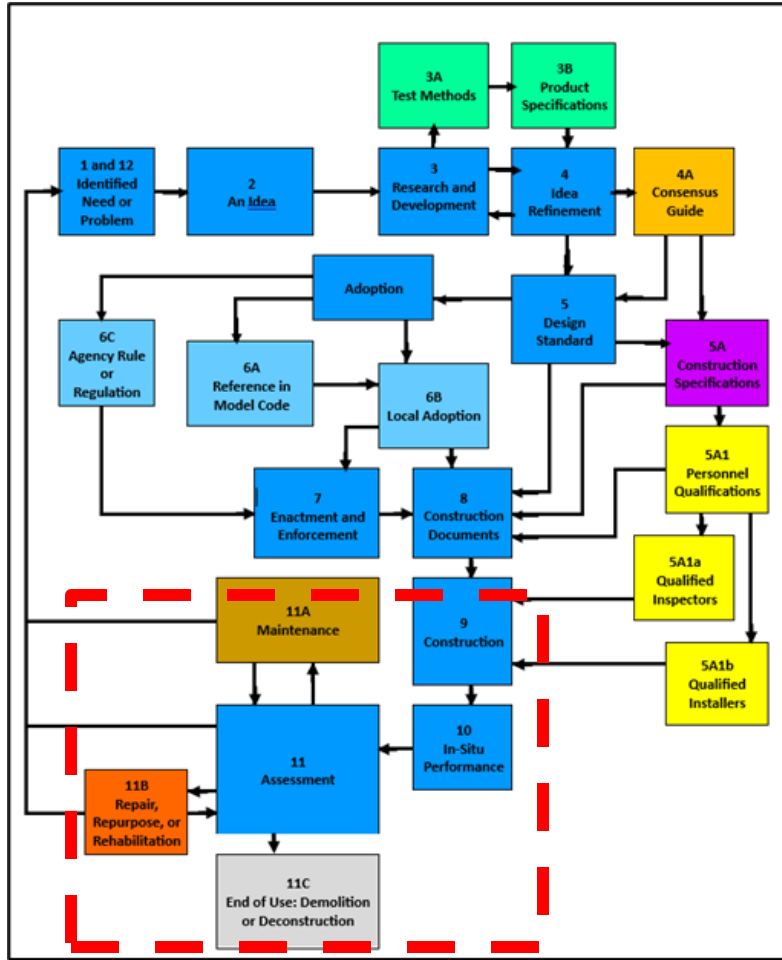
**Application/
Construction (Practice)**

through

**Specification (Instruction)
& Inspection (QA)**



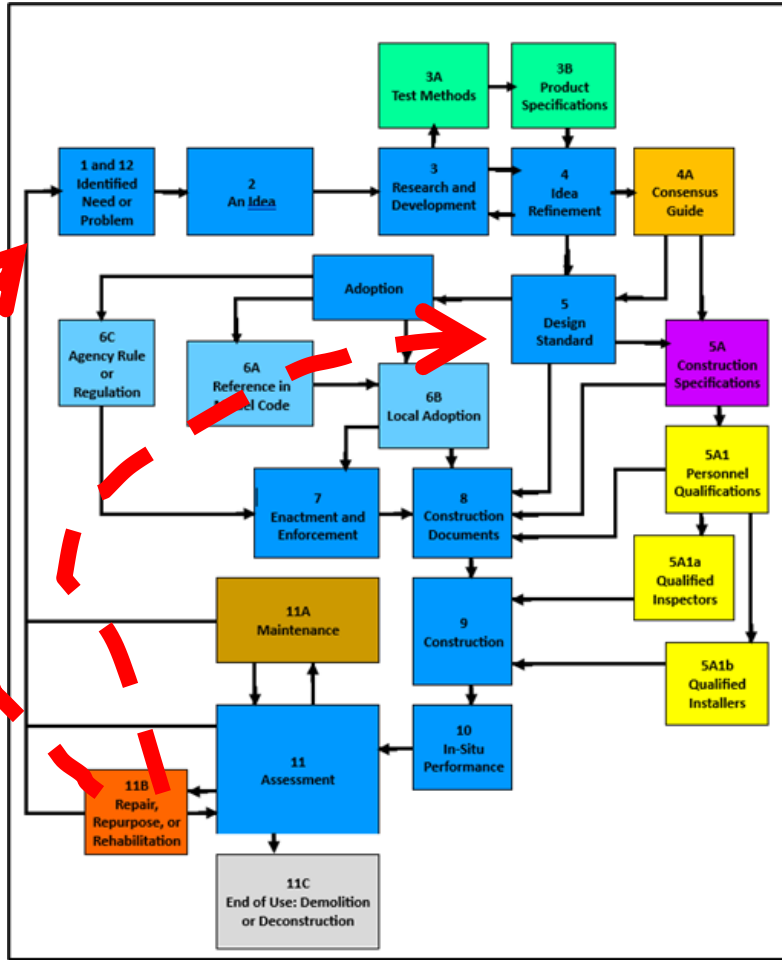
Existing Construction Behavior



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Refinement Towards Progress



Start portions over to revise standards towards continued progress

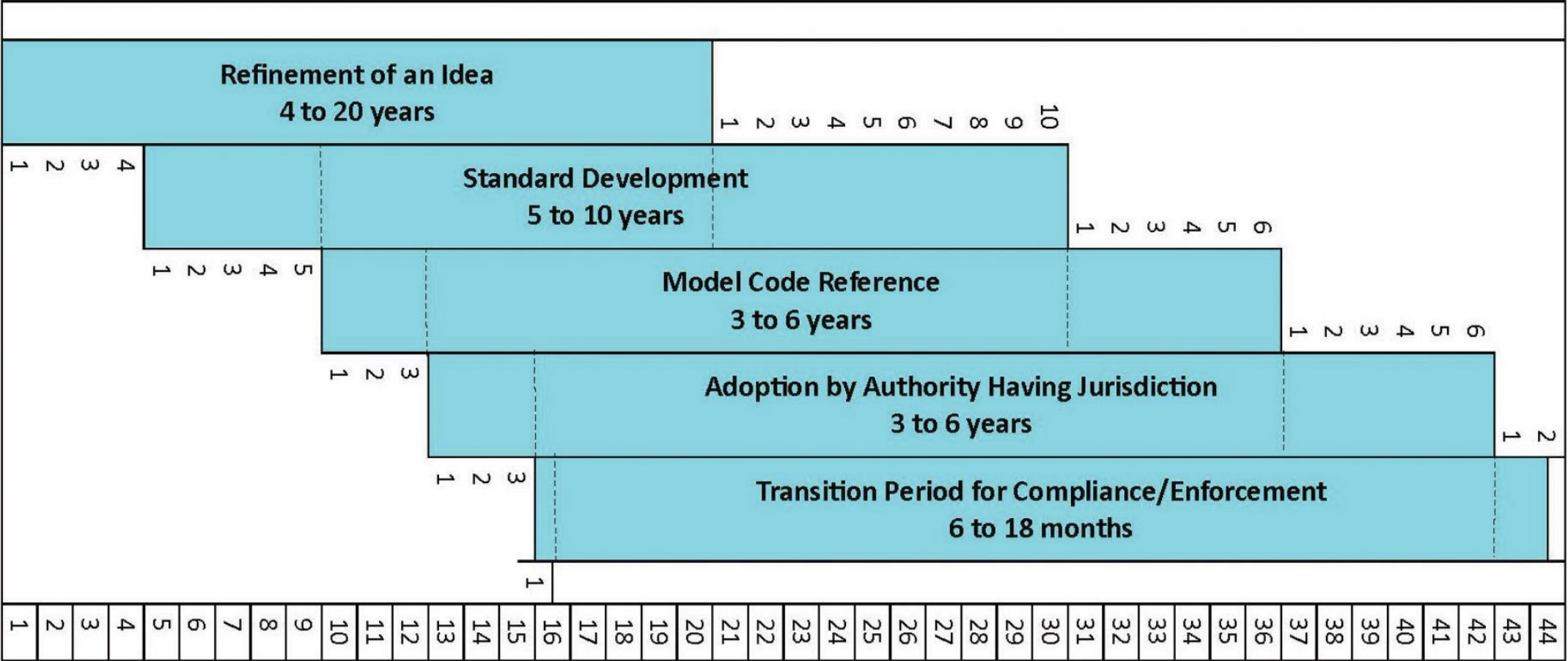
Cyclic



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

aci CONCRETE CONVENTION

Gen. Timeline of Document Development & Adoption



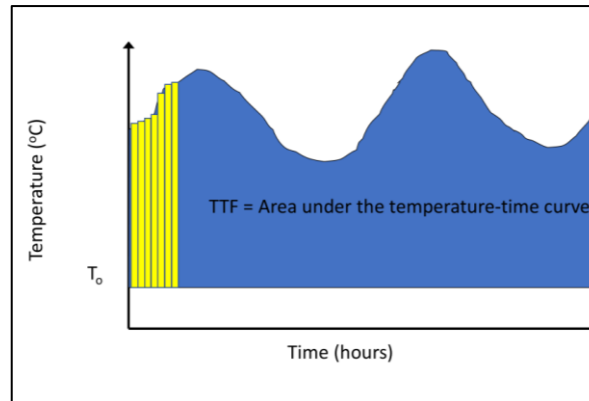
THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Brief Example – Concrete Maturity (NDT)

"Concrete of the same mix at the same maturity (reckoned in temperature-time) has approximately the same strength whatever combination of temperature and time go to make up that maturity."

A.G.A. Saul, 1951



- Idea: Late '40's and early '50's
- Advancements: Late 1970's – early 1980's – Freisleben Hansen, and Pedersen; Carino
- Standard Code: ACI 318-89 (Commentary) 1989



R6.2 – Removal of forms and shores

In determining the time for removal of forms, consideration should be given to the construction loads and to the possibilities of deflections.^{6,3} The construction loads are frequently at least as great as the design live loads. At early ages, a structure may be strong enough to support the applied loads but may deflect sufficiently to cause permanent damage.

Evaluation of concrete strength during construction may be demonstrated by field-cured test cylinders or other procedures approved by the Building Official such as:

(a) Tests of cast-in-place cylinders in accordance with "Standard Test Method for Compressive Strength of Concrete Cylinders Cast-in-Place in Cylindrical Molds" (ASTM C 873). (This method is limited to use in slabs where the depth of concrete is from 5 to 12 in.)

COMMENTARY

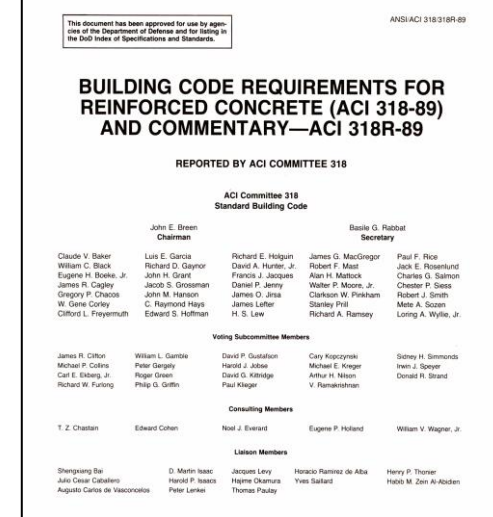
(b) Penetration resistance in accordance with "Standard Test Method for Penetration Resistance of Hardened Concrete" (ASTM C 803).

(c) Pullout strength in accordance with "Standard Test Method for Pullout Strength of Hardened Concrete" (ASTM C 900).

(d) Maturity factor measurements and correlation in accordance with ASTM C 1074.^{6,4}

Procedures (b), (c), and (d) require sufficient data using job materials to demonstrate correlation of measurements on the structure with compressive strength of molded cylinders or drilled cores.

When the structure is adequately supported on shores, the



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Example Scenarios for Development or Modification

- Scenario 1: Standard with an established need but with an approach that is not yet standardized
- Scenario 2: Standard to address a need or demand for providing an alternative design and construction approach
- Scenario 3: New methodologies without new materials
- Scenario 4: Revision to referenced product specifications and test methods

Scenario 1:

Standard with an established need but with an approach that is not yet standardized

- Repair discussed in ACI 201 Committee Report in 1962
 - Historically known
 - Late 20th/Early 21st century initiatives
- CODE-562 published 2013 (rev 2016, 2019, 2021)
- Adoption
 - Locally in some jurisdictions
 - 2024 IEBC as permissible

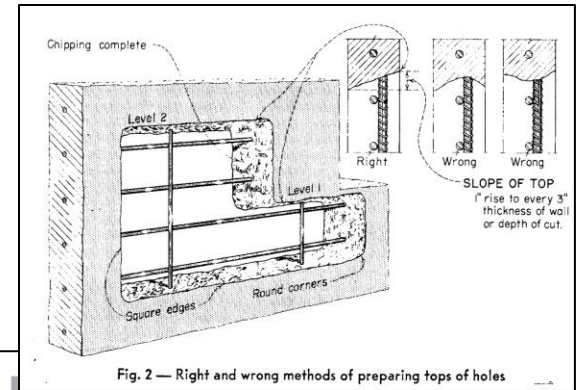
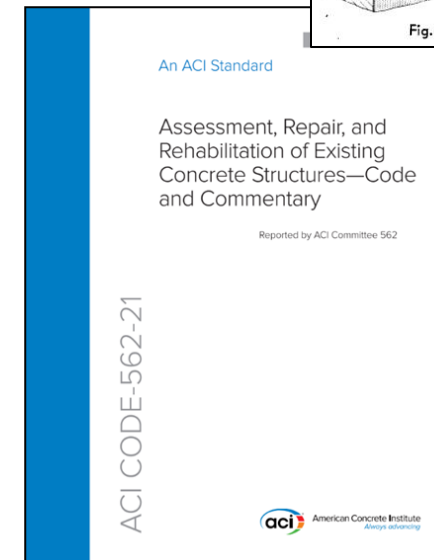


Fig. 2 — Right and wrong methods of preparing tops of holes



ACI 201 Committee Report 59-57 (1962)



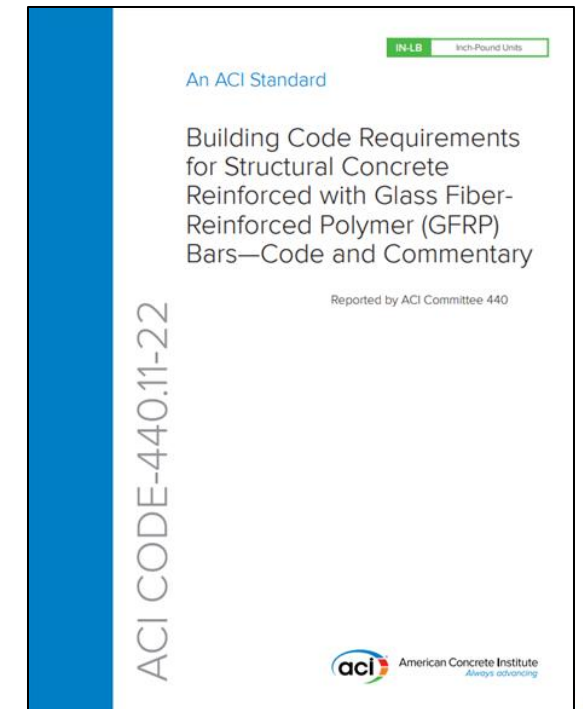
THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

aci CONCRETE CONVENTION

Scenario 2:

Standard to address a need or demand for providing an alternative design and construction approach

- FRP reinforcement considered for concrete in 1960's (ACI 440.1)
 - Alternative approach to use of reinforcing steel
 - Material specifications developed
 - Progressing applications
- CODE 440.11 published 2022
- Adopted by ICC for 2024 International Building Code



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Scenario 3:

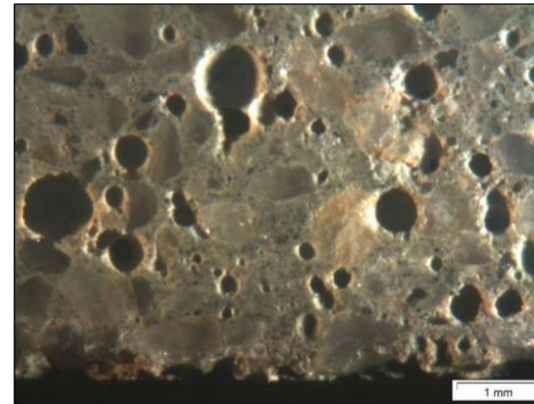
New methodologies without new materials

- Inspection requirements in CODE 318 minimal in 1960's
- U.S. House of Representatives (HR) Report No. 98-621 (1982): Structural Failures in Public Facilities
 - Prompted more substantial Special Inspection Requirements
- Subsequent codes addressed inspections
- ACI CODE-318-19(22) contains 15 specific items required to be either periodically or continuously inspected

Scenario 4:

Revision to referenced product specifications and test methods

- Benefits of air in concrete discovered in late 1930's
 - Early research in late '30's, and '40's and '50's
- ASTM Standards developed early 40's to 50's.
- ACI CODE 318
 - First requirement for air entrainment in 1960's
 - First specific air content requirements in 1971



Summary

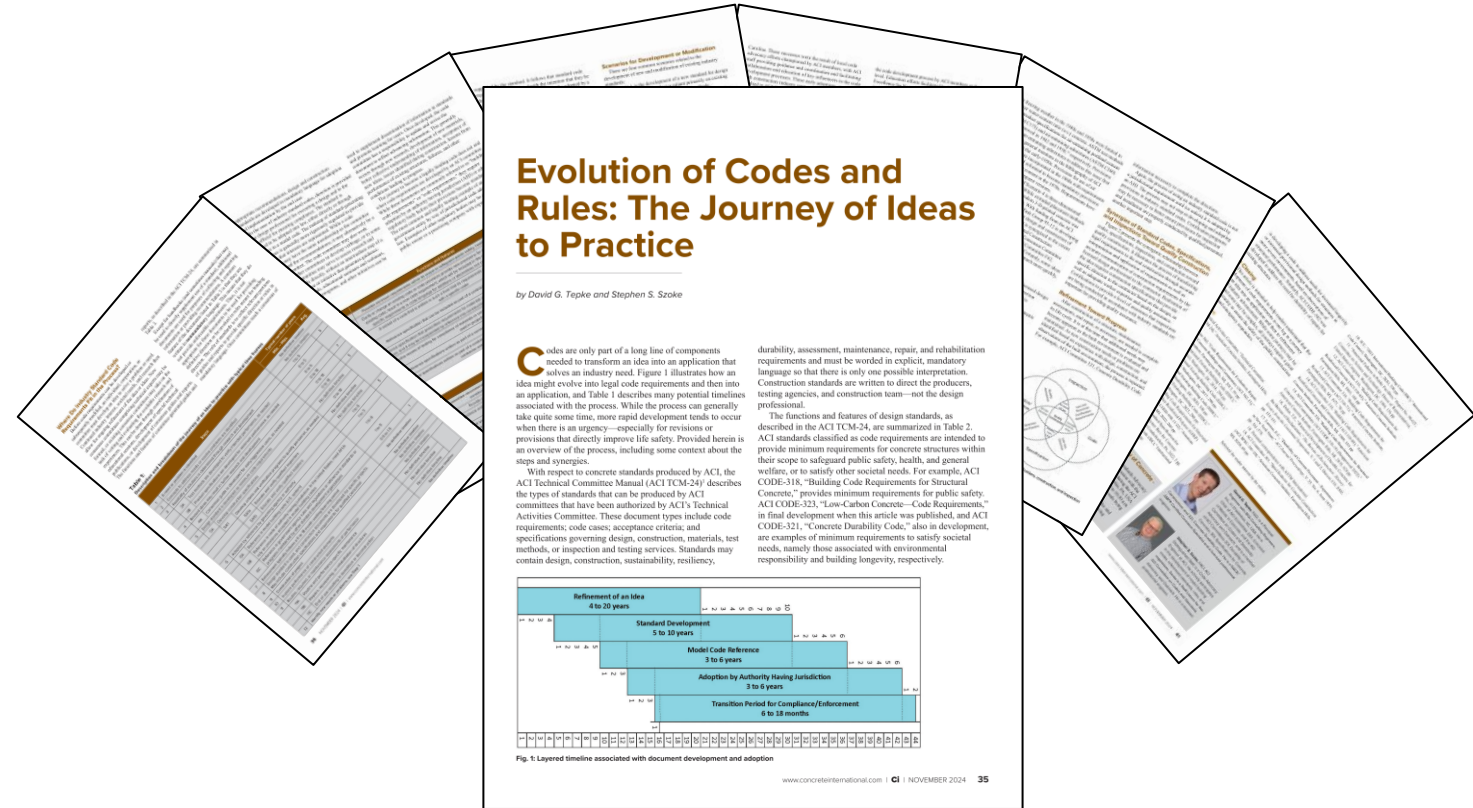
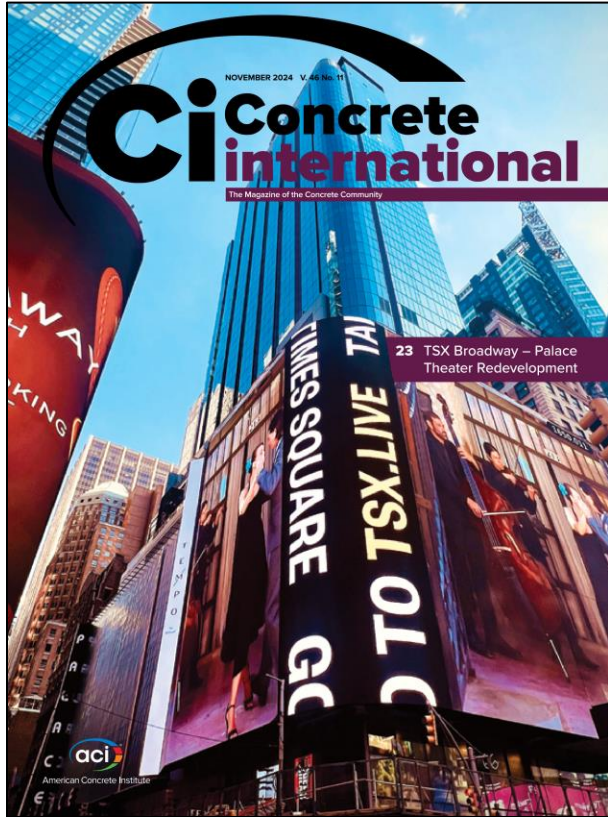
- Standards and guides have different function and purpose
- Many steps on the journey of an idea to regulation and application and then back through the process towards progress
- Timeframe can vary significantly
- Quality construction relies on the relationship of codes and practice through specifications and inspections



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Acknowledgements and Additional Information

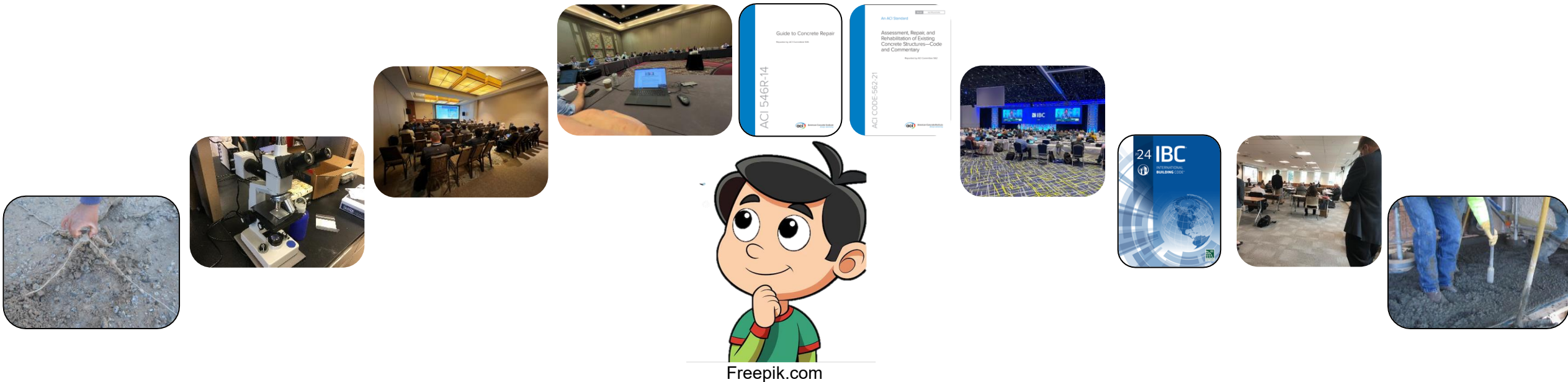


Tepke and Szoke Concrete International | Nov. 2024 (Vol 45, No 11)

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Evolution of an Idea to a Regulation



David G. Tepke, PE, FACI, SKA Consulting Engineers, Inc.

Destiny of Concrete Session | ACI Fall Convention | Philadelphia, PA | Nov. 5, 2024



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

