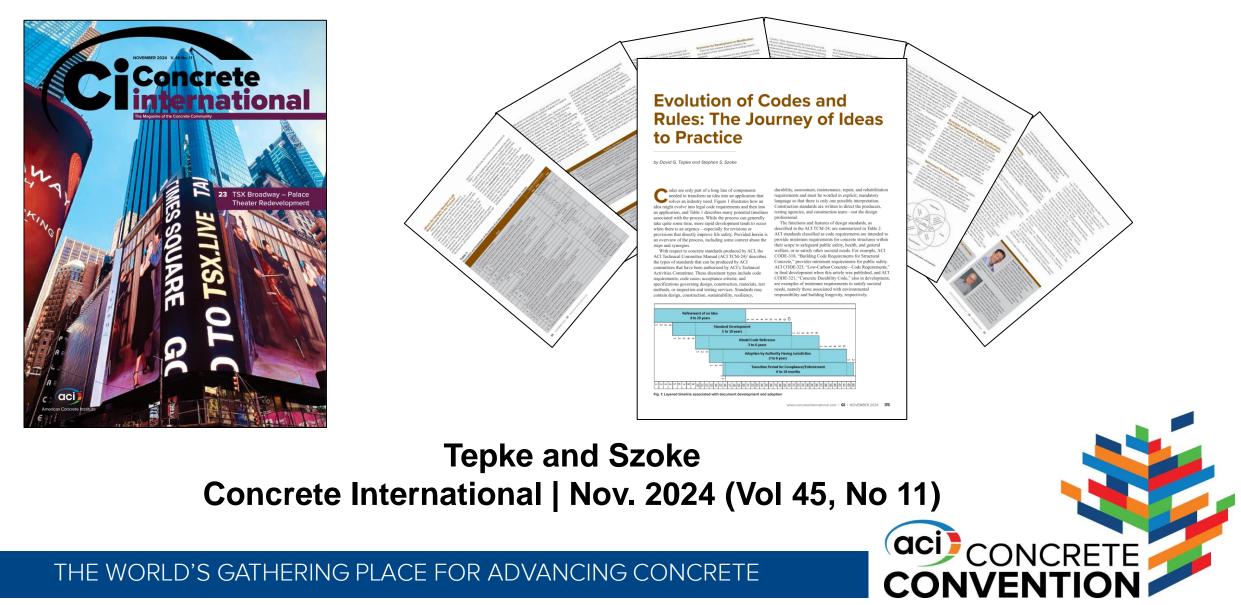
### **Evolution of an Idea to a Regulation**



### **Acknowledgements and Additional Information**



### **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

### **Opening Comments / Focus**

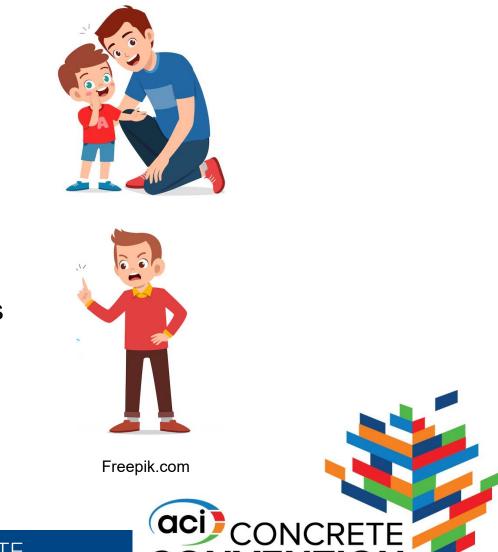
- Regulated / regulatable issues
  - Some technologies for means or non-structural conditions may be different
- ACI process and documents
- Generalized conditions and generalized examples



#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### 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



#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### 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

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

Evolution of an Idea to a Regulation | Tepke, David G. | 2024 ACI Fall Convention Session: Destiny of Concrete – Rules and Regulations | Philadelphia, PA | November 5, 2024

### 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
- Construction Specification
  - Reference standard that can be used as part of contract between Contractor and Owner

Code Case

• Test Method

- Acceptance Criteria Document
- Material Specification

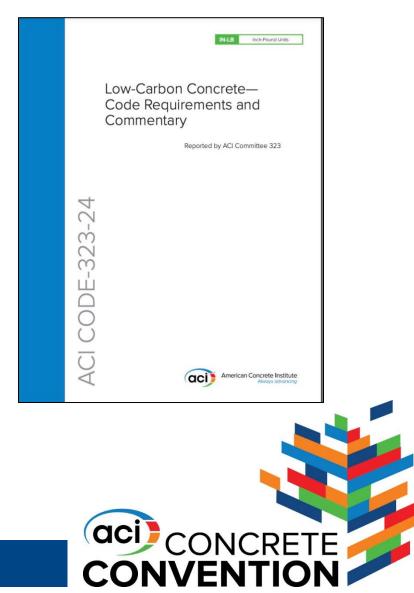
- Inspection Services Specification
- Testing Service Specification



### **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
- <u>CODE 323 Low-Carbon Concrete Code</u>
- 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/

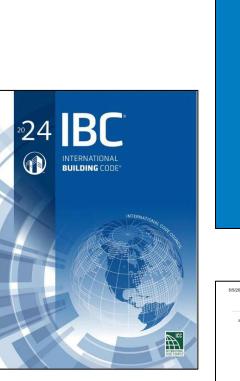
#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

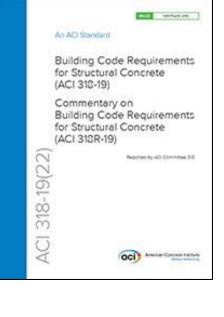


### Difference between a Code... a Code... and a Code...

- 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

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE





	South Carolina Legislature
South Carolina Law > (	Code of Laws > Title 6
	South Carolina Code of Laws Unannotated
	Title 6 - Local Government - Provisions Applicable to Special Purpose Districts and Other Political Subdivisions
	CHAPTER 9
	Building Codes
SECTION 6-9-	5. Public policy for building codes.
safety, and well	oricy of South Carolina is to maintain reasonable standards of construction in buildings and other structures in the State consistent with the public health, tare of its obtainers. To secure these purposes, a parson performing building codes enforcement must be certified by the South Carolina Building Codes as it is necessary to provide for certification.
have been or a	e intent of the General Assembly and address questions which might arise or have arisen with respect to provisions of the nationally known codes which If in place, only those portions or provisions of the nationally known building and alafty codes which whate building attandants and safety are binding local governmental emitty or agency which adopts the building and safety codes autoincat or required by this chapter.
	arify the intent of the General Assembly, Chapter 9, Title 23 continues to apply to a person who may act under authority of the State Fire Manshal and that I inspection duties among local officials is not dictated by Title 6 but remains a matter for the local authority.
HISTORY: 199	7 Act No. 123, Section 7: 2003 Act No. 83, Section 1, eff July 2, 2003.
Code Commiss	ioner's Note
This section wa	s classified as Section 6-9-5 at the direction of the Code Commissioner.
Effect of Ameni	śment
Carolina Code	dment designated the first and second undesignated paragraphs as subsections (A) and (B), substituted 'this chapter' for 'Chapter 9 of Title 6 of the South of Laws' and made a nonsubstitute change in subsection (B), and added subsection (C) relating to persons acting under the authority of the Fire Marshall on of Inspection duries.



### **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

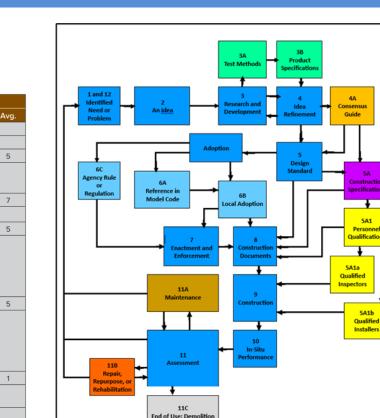
#### Entire Code Development

or

### Provision Development

					Typical number of yea	ars
				Steps	Min. – Max.	Avg
1	A need	or problem	No definitive timeline			
2	Conce	ots to addre	ess needs o	r resolve problems are identified	No definitive timeline	
3	Feasibi	lity of solut	ions is deter	1 to 5	5	
	ЗA	Test met	hods are de	veloped to verify intended performance, as needed	0 to 5	
	3B	Product s	specification	s are developed for minimum performance, as needed	0 to 5	
4	Revise	d ideas may	y result in fu	rther research and development	0 to 10	7
	4A	Consens	us guide is o	0 to 10		
5	Design	standard is	developed	0 to 10	5	
	5A	Develop	construction	n specifications	No definitive timeline	
		5A1	Develop c	riteria and verification programs to qualify personnel, as needed	0 to 10	1
			5A1a	Educate and verify qualified inspectors	No definitive timeline	1
			5A1b	Educate and verify qualified installers	No definitive timeline	
6	Adoptio	on by refere	ence by gov	1 to 6	5	
	6A	Referenc	e in model l	puilding code (U.S. system)	1 to 3	
	6B			authority having jurisdiction. In the United States, most AHJs cepted in model building codes	1 to 6	
	6C		e in govern maintaineo	1 to 5		
7	Enforce	ement typic	ally follows	a 6 to 18 month waiting/learning period	0.5 to 1.5	1
8	· ·		s used, and ruction spec	No definitive timeline	•	
9	Constru	uction of pr	oject	No definitive timeline		
10	In-place	e performar	nce of const	ructed elements	No definitive timeline	
11	Routine, required, or maintenance assessments of performance				No definitive timeline	
	11A	Routine a	and perform	No definitive timeline		
	11B	Repairs, I	repurposing	No definitive timeline		
	11C	End of us	e resulting	No definitive timeline		
12	Identify	new need	s or problen	ns, see Step 1	No definitive timeline	

Tepke & Szoke, 2024



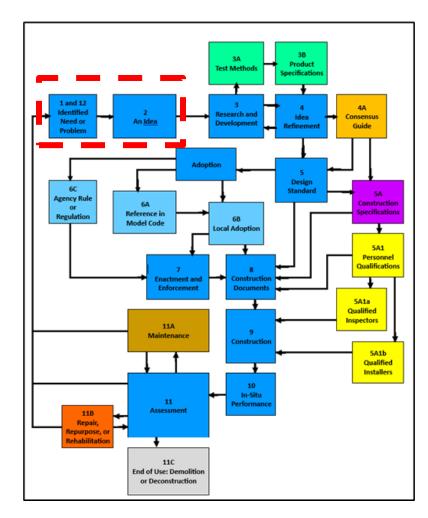
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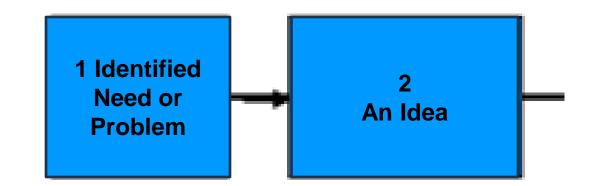
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#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### The Idea or Need to Solve a Problem

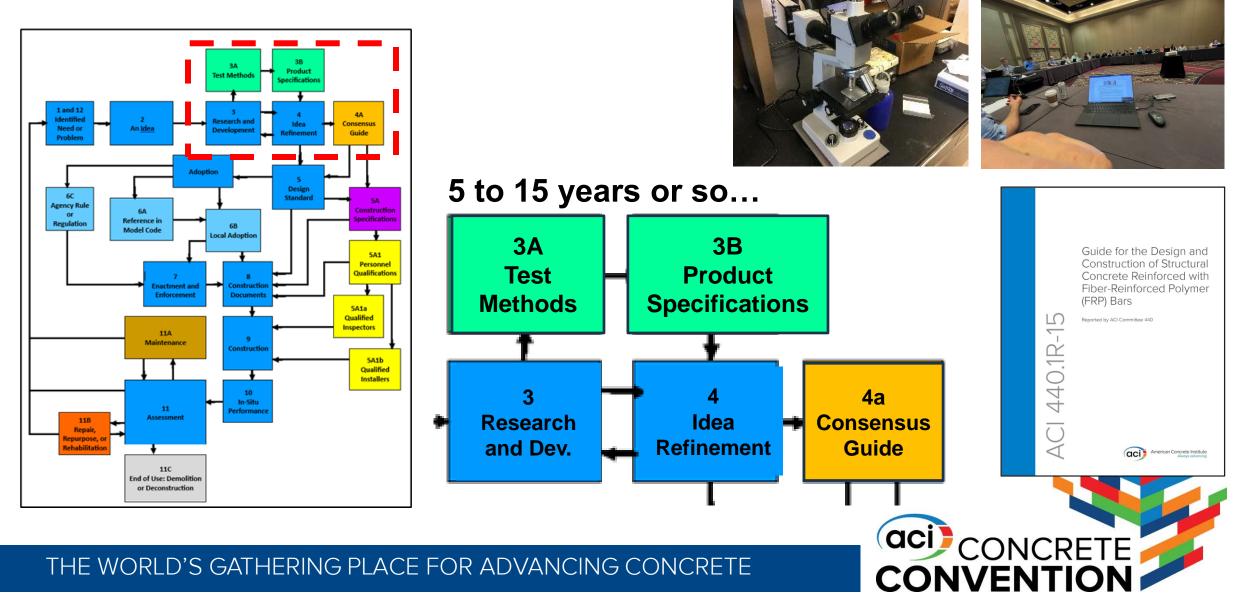




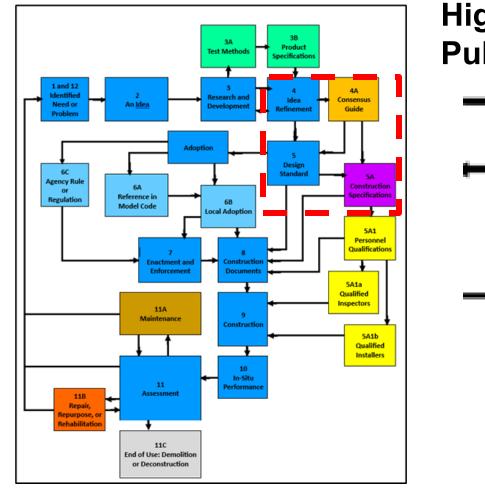


#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### **Refinement / Agreement**

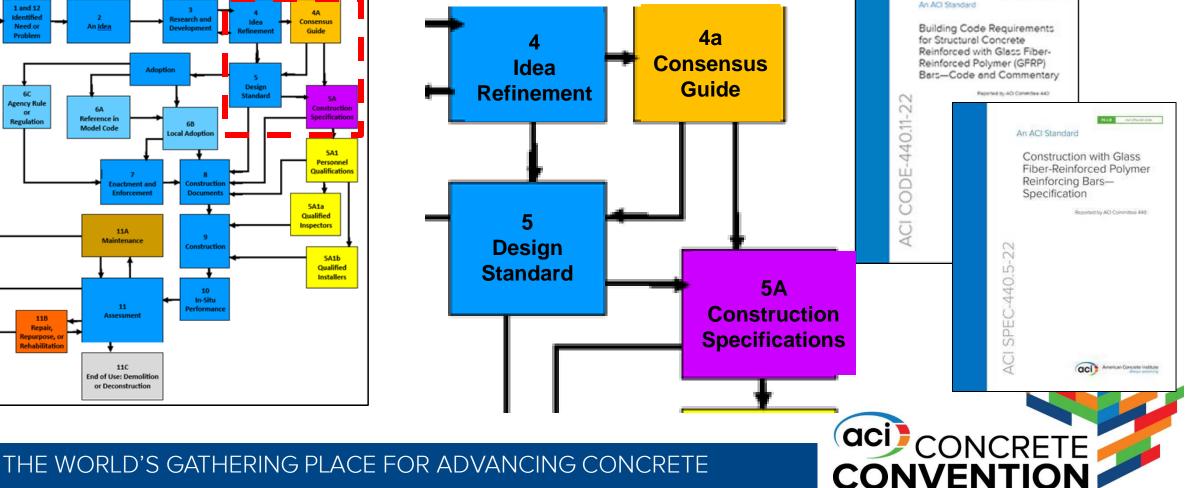


### **Standardization**



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

BLE SURVEY'S



### 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							
1930-1940	(1920) ACI 501-36							
	ACI 501-36			I	I			
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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				
1970-1980	ACI 318-71 ('73,'74,'75,'76s)			(1962)		ACI 350 Report JACI 68-50 (1971)		
	ACI 318-77 ('80s)					ACI 350 Report JACI 74-26 (1977)		
1980-1990	ACI 318-83 ('86s)			ACI 201.2R-77		ACI 350 Report JACI 80-44 (1983)		
	ACI 318-89				ACI222R-85			
THE WORLD	)'S GATHERIN(	G PLACE F <u>or</u>	R ADVANCIN	G CONCRET	Έ		NCRETE	

### Historic Example of Standardization without Guides

	AC	Codes		ACI Committee Guides and Reports			
	ACI 318	ACI 350	ACI 562	ACI 201	ACI 222	ACI 350	ACI 564
	ACI 318-89				AU12228-00		
1990-2000	ACI 318-89 (r92)					ACI 350R-89	
1550-2000	ACI 318-95			ACI 201.2R-92	ACI 222R-96	ACI350R-03	
	ACI 318-99				ACI2226-30		ACI 546R-96
2000 2010	ACI 318-02	ACI 350-01		ACI 201.2R-01			
2000-2010	ACI 318-05			HOIZOI.ZITOT			
	ACI 318-08				ACI 222R-01		ACI 546R-04
	ACI 318-11	ACI 350-06		ACI 201.2R-08			
2010-2020	ACI 318-14	HC1000 00	ACI 562-13				
	MCI 010-14		ACI 562-16				ACI 546R-14
2020	ACI 318-19		ACI 562-19	ACI 201.2R-16	ACI 222R-19		HOIOTOIT IT
2020-present		ACI 350-20	ACI 562-21				

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NCRETE

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### **Education**

to ACI / NR: Manu

MNL-7(23)

**Designing Concrete Structures Reinforced with GFRP Bars Using the** 

New ACI CODE 440.11-22

Pt. 2 - Serviceability and Flexural Design

Presented by:

Dr. Vicki L. Brown, P.E., FACI

Distinguished Professor, Widener University

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American Concrete Institute

GFRP-Reinforced Concrete Design Hendbook

A Companion to AC CODE 44011-23

aci

NEX

Using the New ACL CODE 440.11-22

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se of the Standard Concrete Repair Code

WEBINAR

Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Structures

A Compenion to ACI 552-19

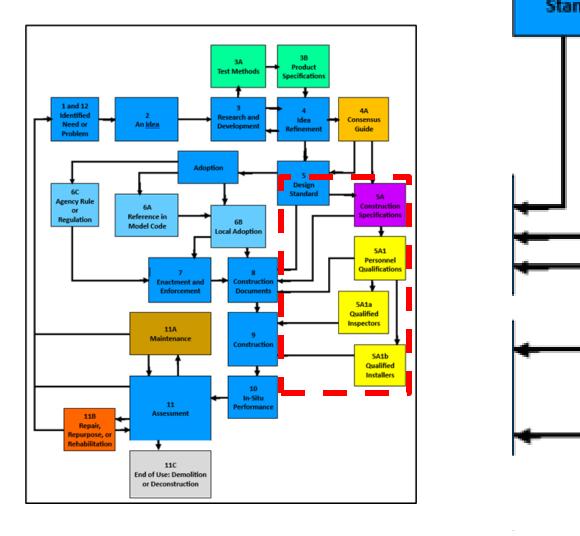
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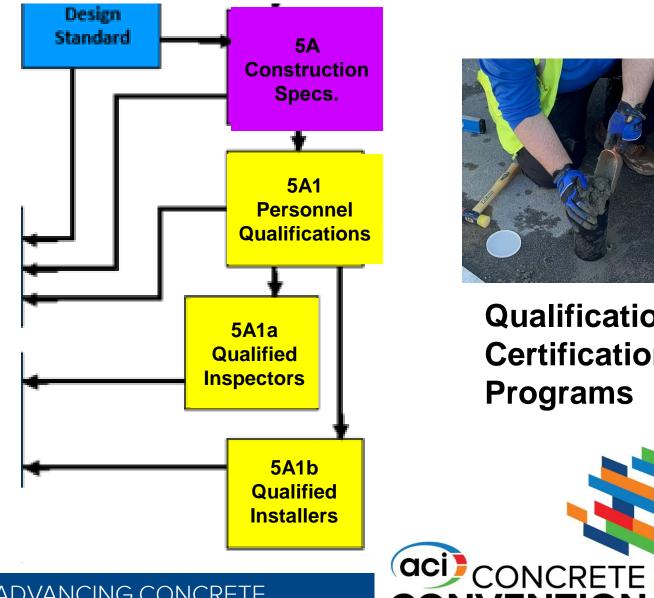
1 and 12 4A Consensus An Idea Need or Guide Adoption Design Standard 54 Agency Rule 64 onstruction cificatio Reference in Regulation 68 Model Code ocal Adoptio ŧ 5A1 Personnel • Qualification actment and Enforcement 5A1a Qualified Inspectors 11A Maintenance nstructi 5A1b Qualified Installers In-Situ 11 Assessment 11B Repair, purpose, o NEW OCI UNIVERSITY 11C End of Use: Demolition or Deconstruction **GFRP Bars Using the** ACI CODE-440.11-22

- Engineers
- Code Officials
- Other stakeholders

THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### **Qualification and Certification**







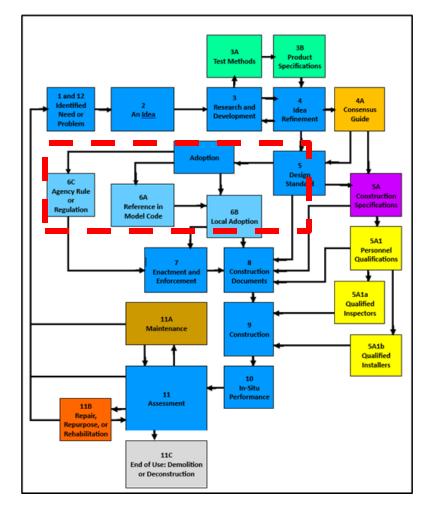
**Qualification &** Certification **Programs** 

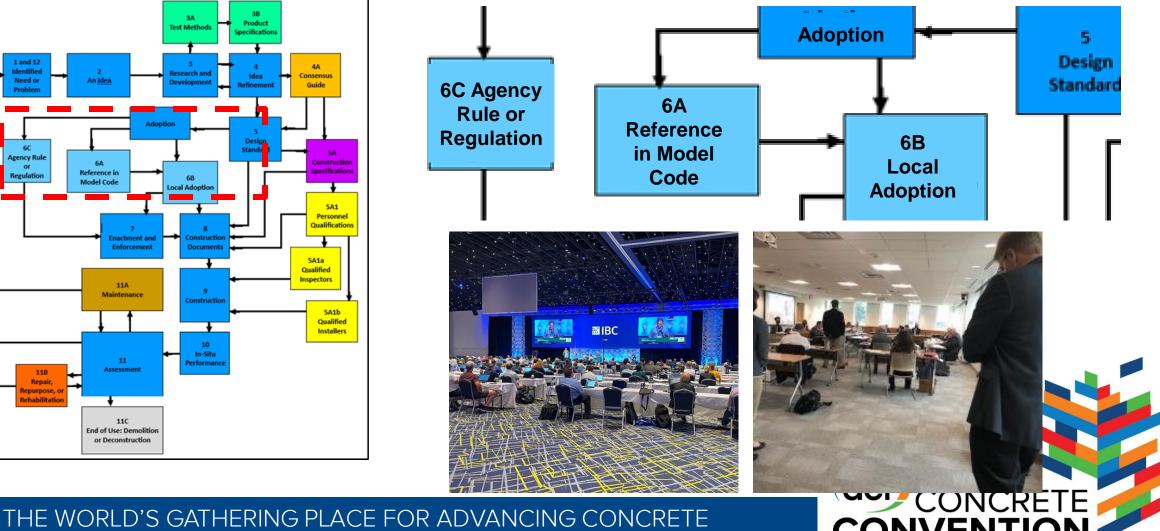
ONVENTION

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### Adoption







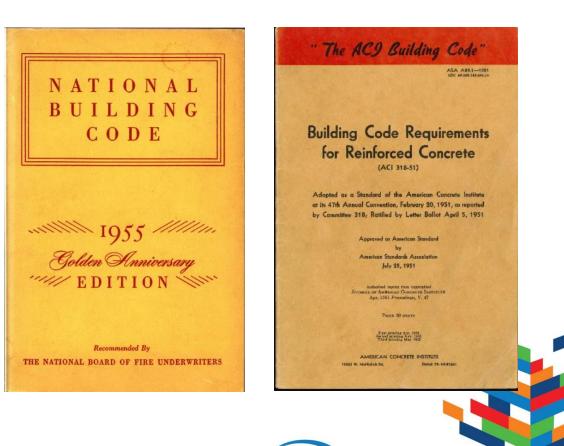
### **Historic Example**

#### City of Charleston Department of Public Service Inspections Division

#### **Building Code Adoption**

1895Chapter XIII, Section 482 of City Ordinances

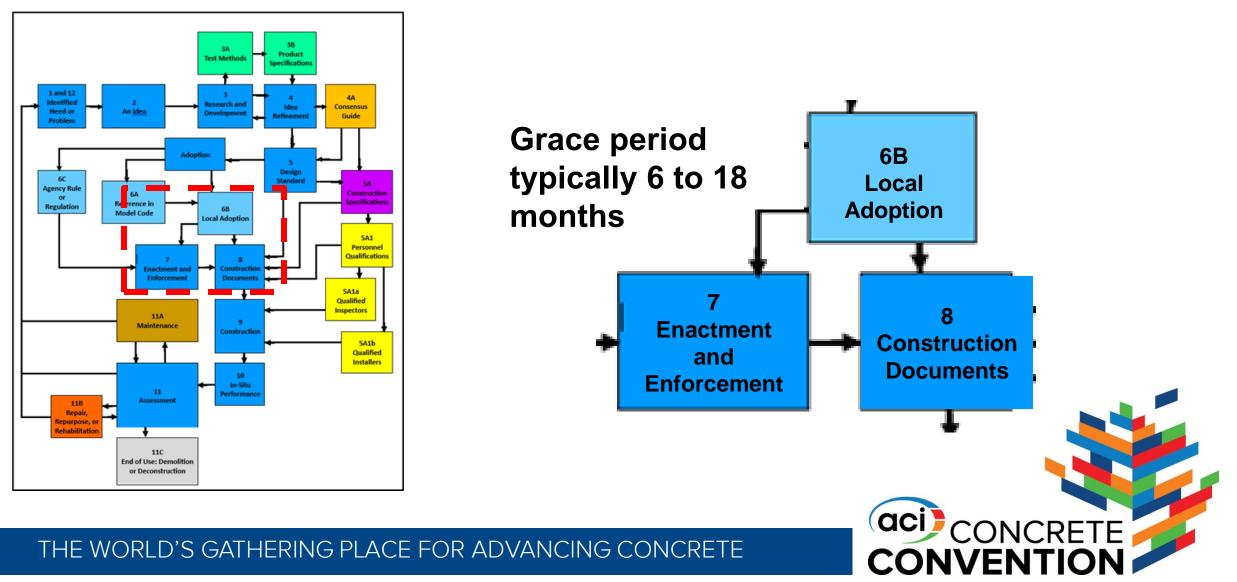
- 1929 Section 684 of City Code, National Board of Fire Underwriters, in addition to requirements prescribed by City Ordinance.
- 1952 Section 9-13, Adopted National Building Code, 1949 Edition
- 1964 Section 10-14, Adopted National Building Code, 1955 Edition
- 1975 Section 10-18, Adopted National Building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



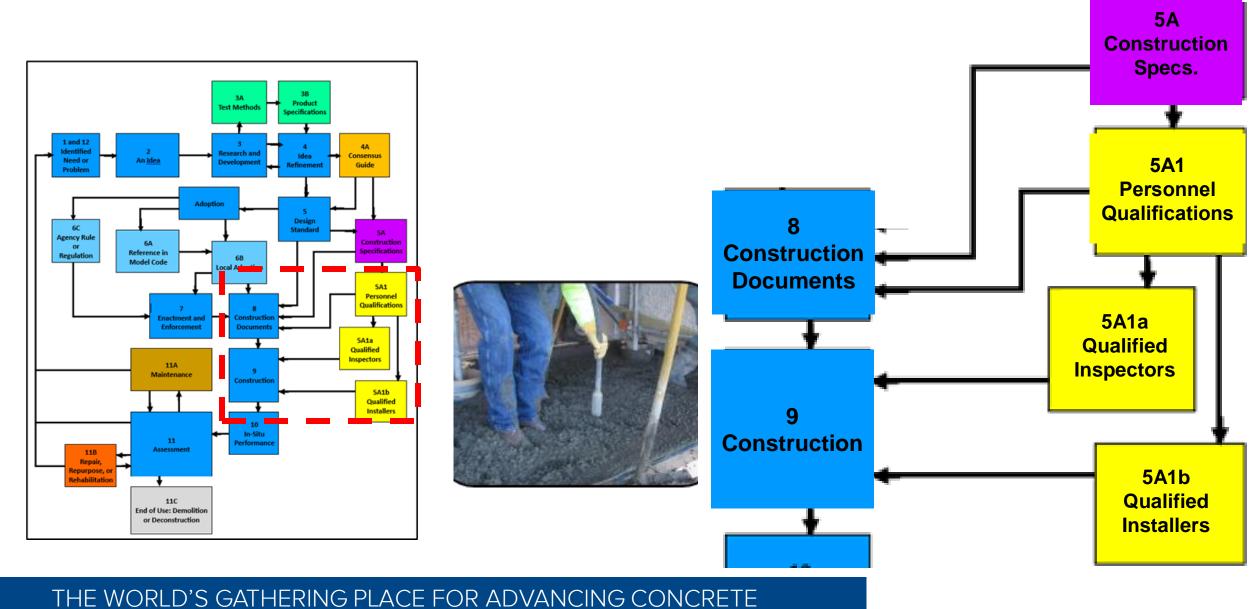
CONVENTION

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

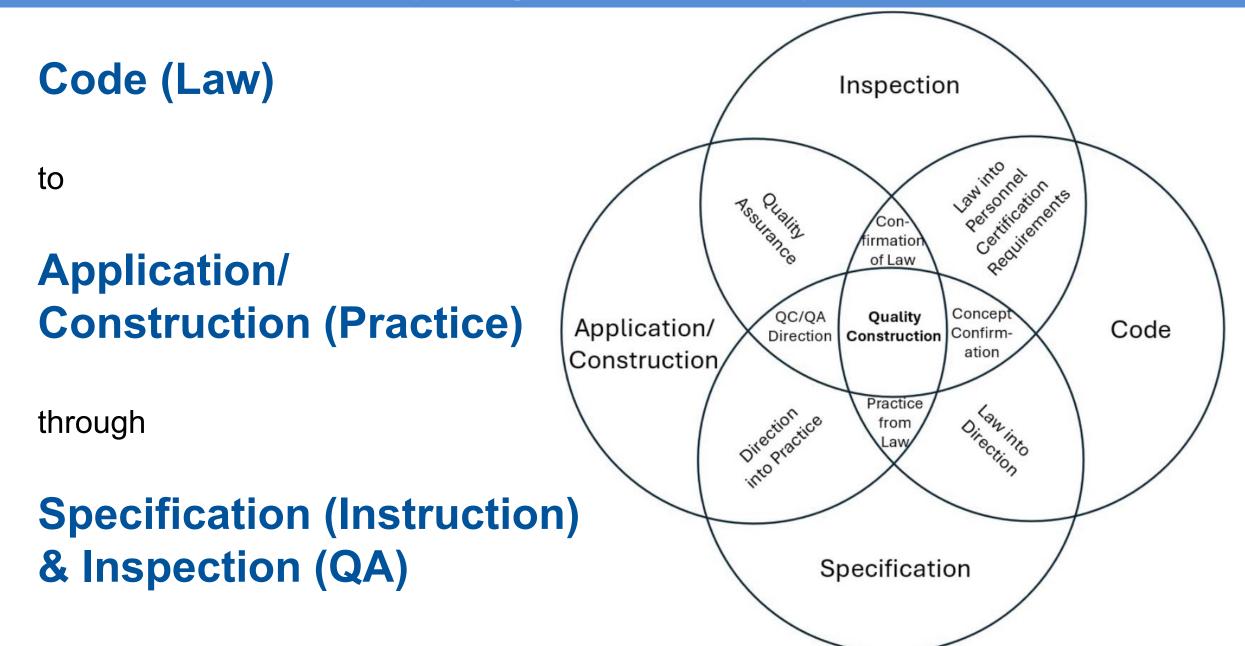
### Enforcement



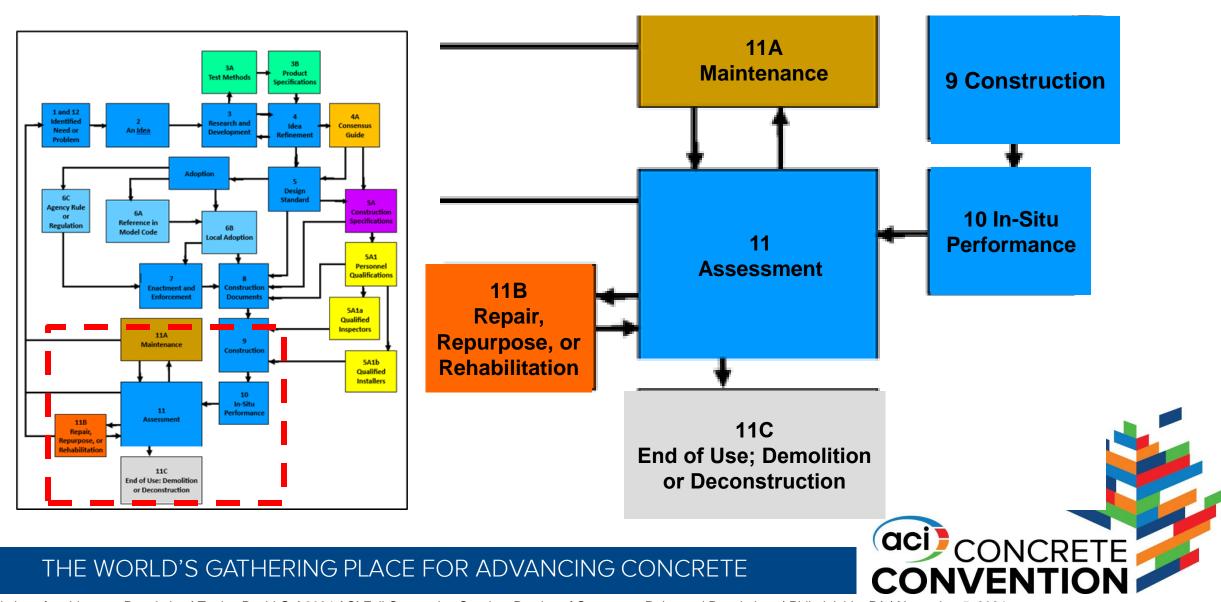
### Construction



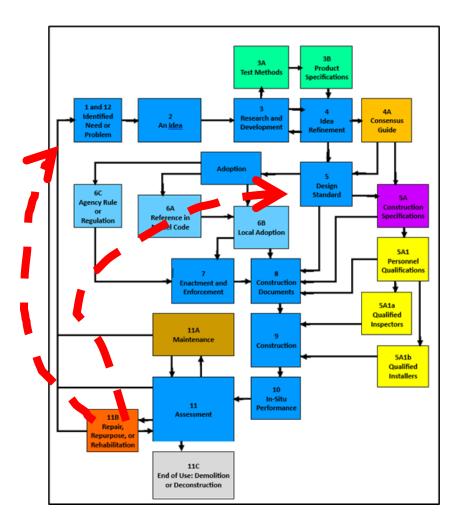
### **Code-Based Synergies for Quality Construction**



### **Existing Construction Behavior**



### **Refinement Towards Progress**



## Start portions over to revise standards towards continued progress

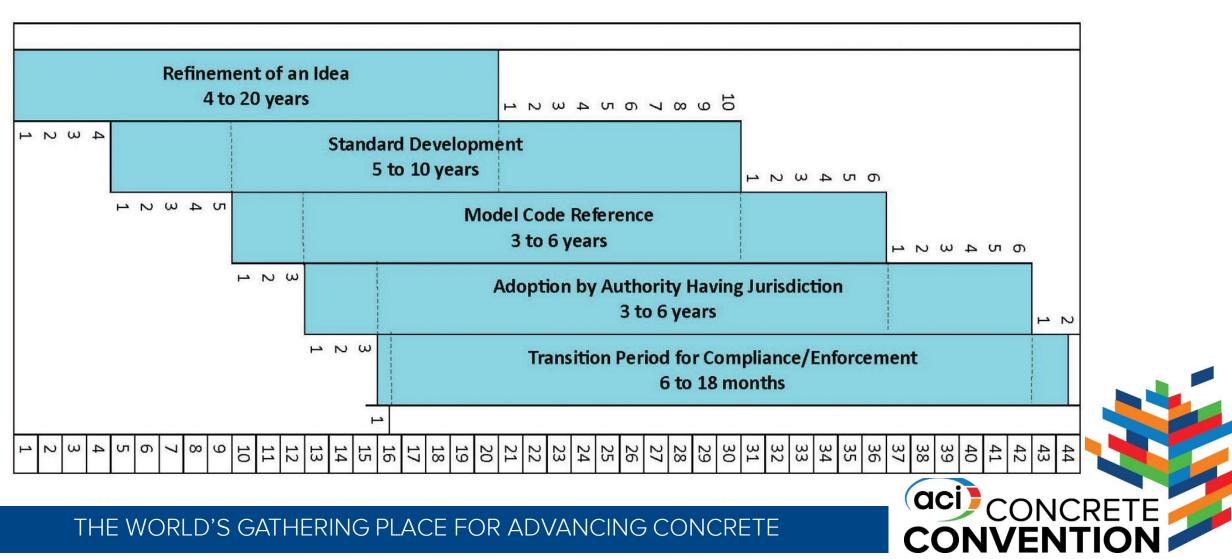
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CONCRETE

### Cyclic

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

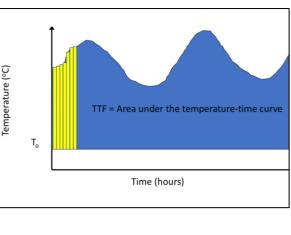
### **Gen. Timeline of Document Development & Adoption**



### **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

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

Evolution of an Idea to a Regulation | Tepke, David G. | 2024 ACI Fall Convention Session: Destiny of Concrete – Rules and Regulations | Philadelphia, PA | November 5, 2024

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#### 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.<sup>6.3</sup> 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.



### **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

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

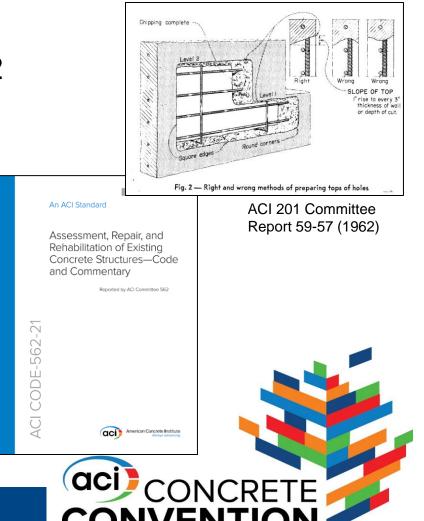
### Scenario 1:

# 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 20<sup>th</sup>/Early 21<sup>st</sup> century initiatives
- CODE-562 published 2013 (rev 2016, 2019, 2021)
- Adoption
  - -Locally in some jurisdictions
  - -2024 IEBC as permissible

#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

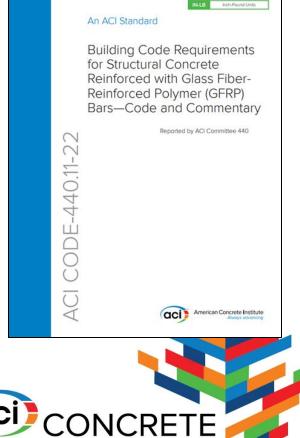


### Scenario 2:

### 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

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### **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

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### **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



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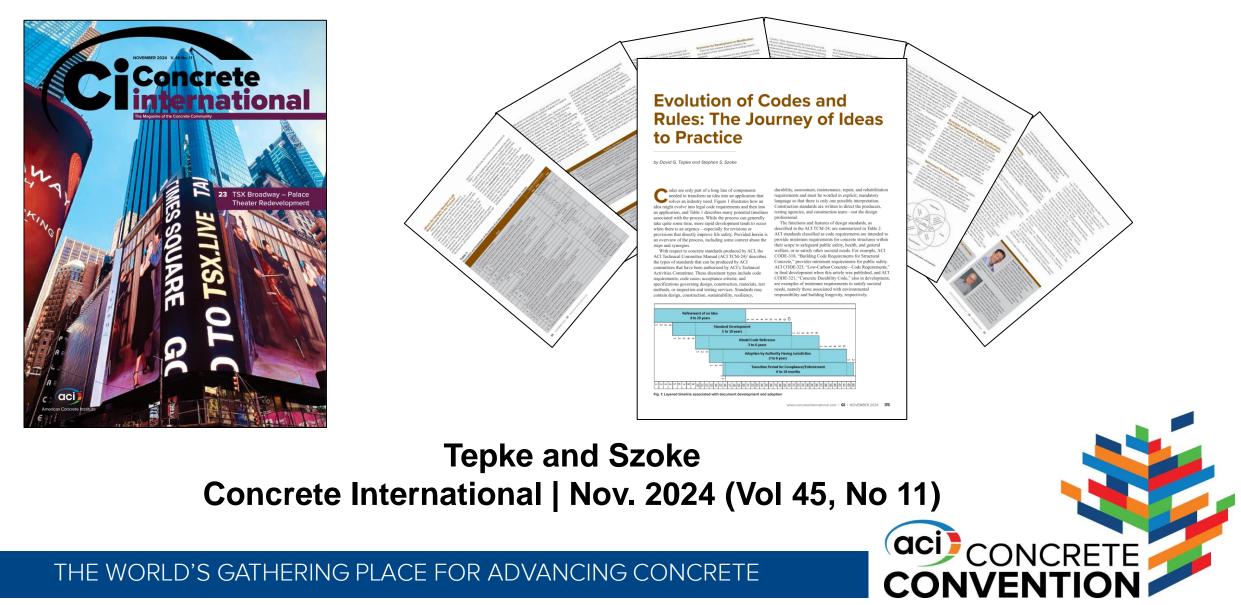
#### THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE

### Summary

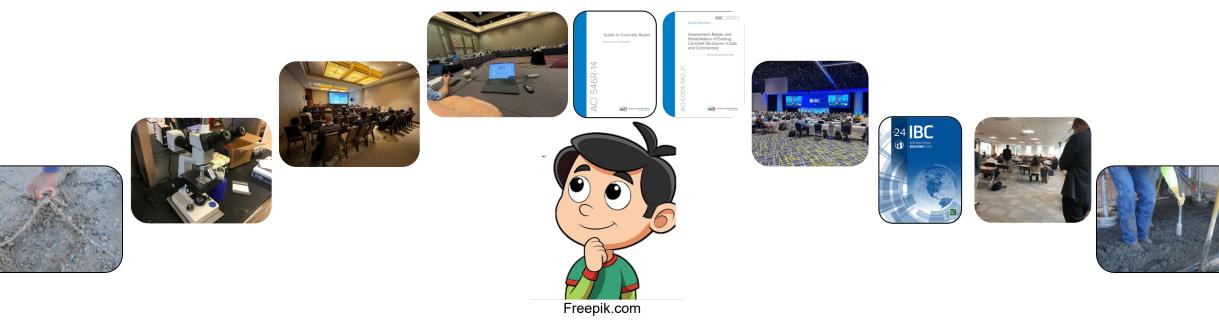
- Standards and guides have different function and purpose
- Many steps on the journey of an idea to regulation and application and then back through the process towards progress
- Timeframe can vary significantly
- Quality construction relies on the relationship of codes and practice through specifications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



### **Acknowledgements and Additional Information**



### **Evolution of an Idea to a Regulation**



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