1. Introduction

CODES, SPECIFICATIONS, and STANDARDS

KOREAN SPECIFICATION for CONCRETE

DESIGN OBJECTIVE and GENERAL APPROACH

DESIGN of REINFORCED CONCRETE

DESIGN PHILOSOPHIES used in RC

SAFETY PROVISIONS of KCI CODE

447.327
Theory of Reinforced Concrete and Lab. I
Spring 2008

1. Introduction

CODES, SPECIFICATIONS, and STANDARDS

1. Building Codes:

- specify minimum design loads
- provide detailed design rules for steel, concrete, etc (by reference)
- provide building height limitations, fire protection requirements, and similar requirements
- purpose is to protect public safety
- *usually* legal documents

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CODES, SPECIFICATIONS, and STANDARDS

1. Building Codes: (cont.)

Examples

- Uniform Building Code (west-coast)
- National Building Code (mid-west, central, east-coast)
- Standard Building Code
- State (e.g. California) and Major City Codes(e.g. Chicago, New York, Los Angeles)

* Korean Society of Civil Engineers (KSCE) - 도로교설계기준
* Architectural Institute of Korea (AIK) - 건축구조설계기준(KBC)

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CODES, SPECIFICATIONS, and STANDARDS

2. Specifications:

design guidelines and recommendations published by recognized engineering societies

Examples

- American Institute of Steel Construction (AISC) – Steel Buildings – LRFD
- American Concrete Institute (ACI) – Concrete Building
- American Association of State Highway and Transportation Officials (AASHTO) – Highway Bridges

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CODES, SPECIFICATIONS, and STANDARDS

2. Specifications: (cont.)

specifications are *not* legal documents, but are usually referenced in building codes.

* Korea Concrete Institute (KCI) - 콘크리트구조설계기준
* Korean Society of Steel Construction (KSSC) - 강구조설계기준

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CODES, SPECIFICATIONS, and STANDARDS

3. Standards:

provide material classification and testing requirements, and specify loads

Examples

- American Society for Testing and Materials (ASTM)
  - chemical and mechanical requirements of steel
  - testing methods of concrete, etc
- American Society of Civil Engineers (ASCE)
  - specifies minimum loads for buildings and other structures

1. Introduction

CODES, SPECIFICATIONS, and STANDARDS

3. Standards:

Standards are *not* legal documents, but are referenced in building and other structures.

* Korean Standards (KS)

KS D: steel

KS F: civil/architecture

KS L: ceramic

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CODES, SPECIFICATIONS, and STANDARDS

COMMENTS

- There are considerable overlap between building codes specifications and standards.
- Codes, Specifications and Standards *do not* cover *every* situation (only routine stuff)
- Judgment and Experience is *still needed!!!*

1. Introduction

KOREAN SPECIFICATION for CONCRETE

1989 한국콘크리트학회(KCI) 창립

1995 시방서/설계기준의 주체로 지정 (건교부)

1999 콘크리트표준시방서(시공편) + 구조설계기준 발간

- ☜ 건축분야의 철근콘크리트구조계산규준 통합

2003 콘크리트구조설계기준 1차 개정판 발간 (ACI 318-95)

- ☜ 콘크리트구조와 강구조의 설계법이 다르고 하중계수도 다르기 때문에 합성구조물 설계 시 혼선이 발생함

2007 콘크리트구조설계기준 2차 개정판 발간

- ☜ ACI 318-05 및 Eurocode 등이 최신 설계기술 반영

1. Introduction

www.moct.go.kr

> 법령자료> 건설교통정보화 > 지식정보사이트 > 건설공사기준정보

1. Introduction

DESIGN OBJECTIVE and GENERAL APPROACH

Objective

A Structure must be able to resist the load effects with an "appropriate" margin of safety against "failure".

Failure is defined as that condition at which structure cease to fulfill its intended purpose.

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DESIGN OBJECTIVE and GENERAL APPROACH

Objective (cont.)

To satisfy this objective the structure must be:

Safety Fracture or buckling of reinforcing bars, crushing of the concrete must be avoided under service load.

Functional Deflection, vibration, water tightness, noise must be controlled.

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Objective (cont.)

- *Safety*

Member action ≤ Strength provided
(M. V. P)

- *Functional*

Deformations, vibrations ≤ Limits
under service loads

Note: This concept (approach) applies not only to concrete structures, but to steel, wood, masonry and other structures

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DESIGN of REINFORCED CONCRETE

A large number of parameters have to be dealt with in proportioning a reinforced concrete element. This includes:

- width
- depth
- amount of reinforcement
- steel strain
- concrete strain
- etc.

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DESIGN of REINFORCED CONCRETE

Design Procedure

1. *Trial and adjustment* are necessary in the choice of concrete sections to meet the design requirements.

2. Such an array of parameters *should* be considered, because of the fact that RC is *often* a site-constructed composite, in contrast to the steel structures of which beam and column sections are fabricated in standard.

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DESIGN of REINFORCED CONCRETE (cont.)

3. A trial section has to be selected for each critical location in a structural system.

4. The trial section has to be analyzed to determine if its nominal resistance is adequate to carry the applied factored load.

5. Since more than one trial is often necessary to arrive at the required section.

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DESIGN of REINFORCED CONCRETE (cont.)

6. The trial-and-adjustment procedures for the choice of a concrete section leads to the convergence of *analysis and design*.

7. Hence, EVERY DESIGN IS ANALYSIS ONCE A TRIAL SECTION IS SELECTED.

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DESIGN PHILOSOPHIES used in RC

I. Working Stress Design - WSD or ASD
- traditional approach until the 1960s.
- rarely used in practice today

II. Ultimate Strength Design - USD or LSD or LRFD
- first published in the 1956 ACI spec.
- current state of practice

Difference: How the "margin of safety" is incorporated in design. The both, however, provide *comparable* design in terms of structural safety and serviceability.

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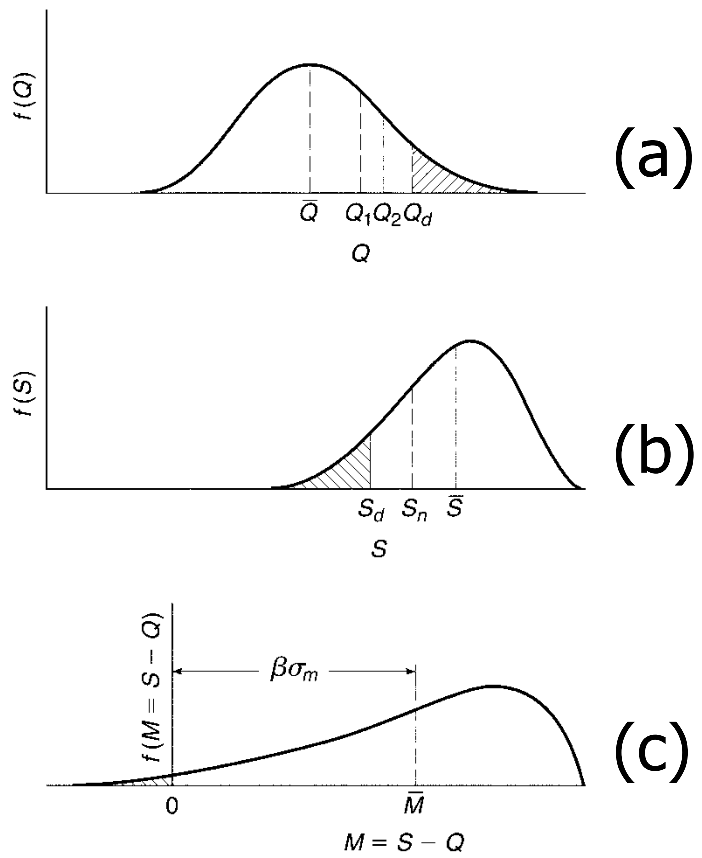
DESIGN PHILOSOPHIES used in RC

<u>*Safety Margin*</u>

Q: Loads
S: Strength

$M = S - Q$

$P_{failure}$ = Probability of [M<0]
(shaded area in (C))



1. Introduction

DESIGN PHILOSOPHIES used in RC

Ultimate Strength Design -USD

Definition

- Load: structure is analyzed using factored load, i.e., "service loads" (code specified loads) multiplied by load factor

- Strength: member strength is expressed in terms of the nominal strength multiplied by a resistance factor

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DESIGN PHILOSOPHIES used in RC

Ultimate Strength Design -USD

Requirement

$$\sum \gamma_i Q_i \leq \phi S_n$$

Q_i = load effect or member actions under S.L.

γ_i = load factor

S_n = nominal strength

ϕ = resistance factor (strength reduction factor)

$\sum$ implies various load combinations

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DESIGN PHILOSOPHIES used in RC

Required Strength γQ_i

Load factor γ accounts for uncertainties in

1) the magnitude of the calculated load
2) the manner in which different load types are likely to be combined during the service life of the structure
3) the assumptions in the modeling and analysis of the structure

depends on the load type and load combination

⇦ specified by standards and codes

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SAFETY PROVISIONS of KCI CODE

$$Design\ strength \geq Required\ Strength$$

$$\phi S_n \geq U$$

In specific terms for a member subjected to moment, shear, and axial load.

$$\phi M_n \geq M_u$$

$$\phi S_n \geq S_u$$

$$\phi P_n \geq P_u$$

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SAFETY PROVISIONS of KCI CODE

Factored Load Combinations (KCI 3.3.2)

The required strength *U* is calculated by applying load factors to the respective service load:

Dead load	*D*
Live load	*L*
Wind load	*W*
Snow load	*S*
Rain load	*R*
Earthquake load	*E*
Fluid pressure	*F*
Earth Pressure	*H*
Impact allowance	*I*
Environmental effects	*T*

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SAFETY PROVISIONS of KCI CODE

Factored Load Combinations (KCI 3.3.2)

KCI-2003	KCI-2007
$U = 1.4D + 1.7L$	$U = 1.4(D + F + H_v)$
$U = 0.75(1.4D + 1.7L + 1.7W)$	$U = 1.2(D + F + T) + 1.6(\mathrm{L} + a_H H_v + H_h)$ $+ 0.5(L_r$ 또는 S 또는 $R)$
$U = 0.9D + 1.3W$	
$U = 0.75(1.4D + 1.7L + 1.8E)$	$U = 1.2D + 1.6(L_r$ 또는 S 또는 $R)$ $+ (1.0L$ 또는 $0.65W)$
$U = 0.9D + 1.4E$	
$U = 1.4D + 1.7L + 1.8H$	$U = 1.2D + 1.3W + 1.0L + 0.5(L_r$ 또는 S 또는 $R)$
$U = 0.9D + 1.8H$	
$U = 1.4D + 1.7L + 1.5F$	$U = 1.2D + 1.0E + 1.0L + 0.2S$
$U = 0.9D + 1.5F$	$U = 0.9D + 1.3W + 1.6(a_H H_v + H_h)$
$U = 0.75(1.4D + 1.7L + 1.5T)$	$U = 0.9D + 1.0E + 1.6(a_H H_v + H_h)$
$U = 1.4D + 1.5T$	
$*U = 1.4(1.1)D + 1.7L$ $= 1.54D + 1.7L$	$U = 1.2(D + F + T) + 1.6(L + a_H H_v) + 0.8H_h$ $+ 0.5(L_r$ 또는 S 또는 $R)$

1. Introduction

Strength Reduction Factor

Condition	KCI-2007	ACI-03/05 ACI-99 Appdix.	Condition	KCI-2003	ACI - 99
Tension controlled section	0.85	0.90 0.80	Flexure/Tension/ Flexure-Tension	0.85	0.90
Compression controlled section -spiral -the others	 0.70 0.65	 0.70 0.65	Compression /Flexure-Comp. -spiral -the others	 0.75 0.70	 0.75 0.70
Shear and Torsion	0.75	0.75	Shear and Torsion	0.80	0.85
Bearing	0.65	0.65	Bearing	0.70	0.70
Plain concrete	0.55	0.55	Plain concrete	0.65	0.65
Post-tensioned Anchorage zone	0.85	0.85			
Strut-tie model	0.75	0.75			
Pre-tensioned	0.75~0.90	0.75~0.90			

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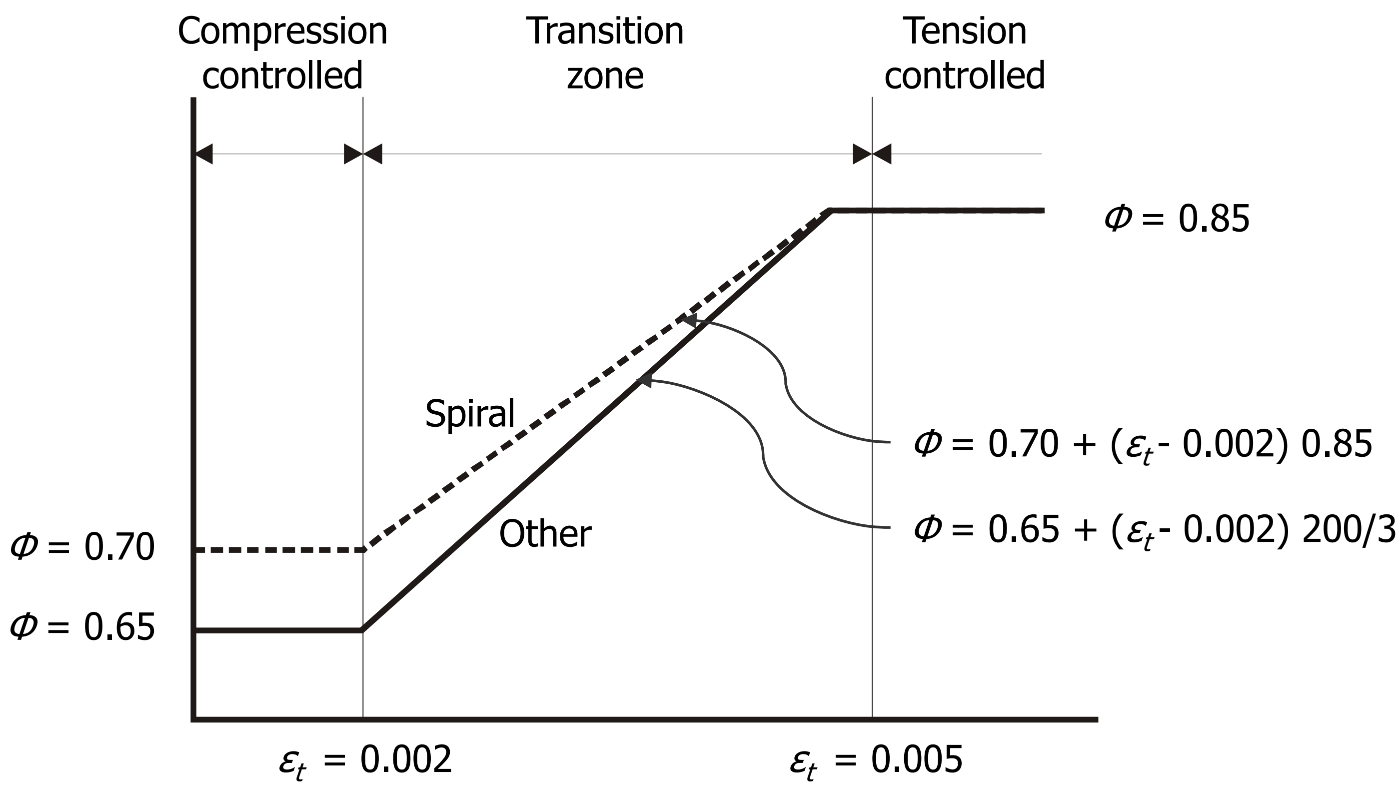
SAFETY PROVISIONS of KCI CODE

Strength Reduction Factor (KCI 3.3.3)



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