CHAPTER

1

Prentice Hall

REINFORCED CONCRETE

A Fundamental Approach - Fifth Edition

INTRODUCTION

A. J. Clark School of Engineering •Department of Civil and Environmental Engineering

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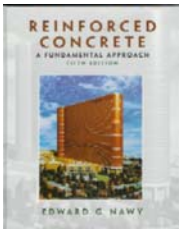

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ENCE 454 – Design of Concrete Structures

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Historical Development of Structural Concrete

- Concrete and its volcanic constituents, such as pozzolanic ash, have been used since the days of the Greeks and Romans.
- *Early part of 19th century:* more intensive use of the material.
- *1801:* weakness of concrete in tension was realized by F. Coignet.
- *1850:* A small cement boat was constructed by Lambot for 1855 world Fair in Paris.

Historical Development of Structural Concrete (cont'd)

- *1867:* A design of metal frames as reinforcement for concrete garden plant containers was patented by the French gardener J. Monier.
- 1886: First manuscript on the theory and design of concrete structures was published by Koenen.
- *1906:* C. A. P. Turner developed the first flat slab without beams.

Historical Development of Structural Concrete (cont'd)

- *By 1910:* German Committee for Reinforced Concrete, Austrian Concrete Committee, the American Concrete Institute (ACI), and the British Concrete Institute were already established.
- *By 1920:* many structures such as buildings, bridges, liquid containers of reinforced concrete were already constructed.

Historical Development of Structural Concrete (cont'd)

- *1938:* ultimate-strength theories were codified in the USSR.
- *1956:* ultimate-strength theories were codified in England and the U.S.
- 1956 – present: high-strength concretes of a strength in compression up to 20 ksi (137.9 MPa) and 1.8 ksi (12.41 MPa) in tension were developed.

Basic Hypothesis of Reinforced Concrete

- Concrete is a mixture of cement, fine and coarse aggregates, and water.
- Water is the key ingredient for chemical reaction for curing.

Add Water

↓

Cement + Aggregates = Concrete

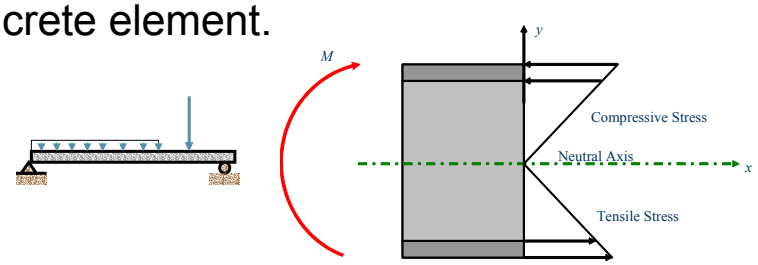
Basic Hypothesis of Reinforced Concrete

Basic Hypothesis of Reinforced Concrete

- The plastic mix is placed and consolidated in the formwork and, then cured to facilitate the acceleration of the chemical hydration reaction of the cement-water mix, resulting in *hardened concrete.*
- The finished product has
  - High **compressive strength**, and
  - Low **resistance to tension** (weak in tension)

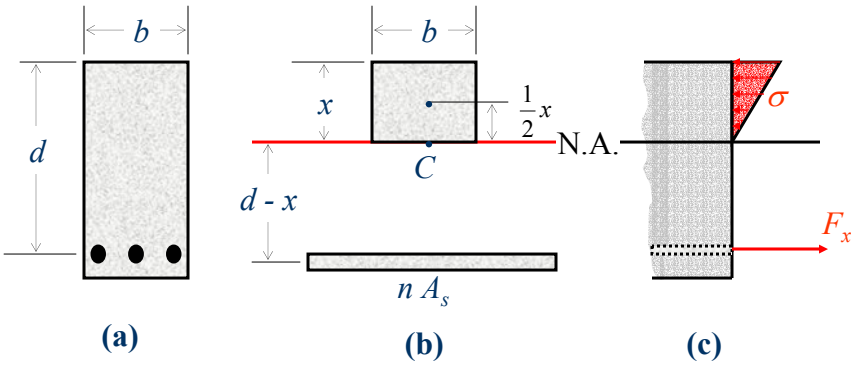
Basic Hypothesis of Reinforced Concrete

- Therefore, tensile and shear reinforcement in the tensile regions of the section has to be provided to compensate for the weak-tension regions in the reinforcement concrete element.



Basic Hypothesis of Reinforced Concrete

- Reinforced Concrete Beam



Basic Hypothesis of Reinforced Concrete

- Concrete Strength (cont'd)
  - Reinforced Concrete Beam

  - ***Concrete is very weak in tension, so it will crack below the neutral surface and the steel rods will carry the entire tensile load.***
  - ***The upper part of the concrete beam will carry the compressive load.***

Basic Hypothesis of Reinforced Concrete

- Modified Approach to basic Principles of Structural Design
  - It is this deviation in the composition of a reinforced concrete (R/C) section from the homogeneity of standard wood or steel sections that requires a modified approach to the basic principles of structural design.
  - The two components of the heterogeneous R/C section are to be so arranged and proportioned that optimal use is made of the materials involved.

Analysis Versus Design of Sections

- A large number of parameters have to be dealt with in proportioning a reinforced concrete element. This includes:
  - Width
  - Depth
  - Area of reinforcement
  - Steel strain
  - Concrete strain
  - Steel stress
  - Etc.

Analysis Versus Design of Sections

- Therefore, trial and adjustment are necessary in the choice of concrete sections to meet the design requirements.
- Such an array of parameters has to be considered because of the fact that reinforced concrete is often a site-constructed composite, in contrast to the standard fabricated beam and column sections in steel structures.

Analysis Versus Design of Sections

- A trial section has to be selected for each critical location in a structural system.
- The trial section has to be analyzed to determine if its nominal resistance is adequate to carry the applied factored load.
- Since more than one trial is often necessary to arrive at the required section, the first design input step generates a series of *trial-and-adjustment* analysis.

Analysis Versus Design of Sections

- The trial-and-adjustment procedures for the choice of a concrete section leads to the convergence of analysis and design.
- Hence, every design is an analysis once a trial section is selected.