Babylon University

College of Engineering

Architectural Department

Lectures of

Structure II

- **Instructor:**

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- **4 hours per week**

- **Conduct**

First term	Second term	Final exam
20%	20%	60%

Every Term

5% : Quizzes and homework

15%: Term exam

******Based on the ACI 318-05 Building Code**

Content of first term

• Introduction, Materials and Properties	1 week
• Specifications, Loads, and Design Methods	2 week
• Strength of Rectangular Section in bending	4 week
• Double RC Beam	2 week
• Shear and Diagonal Tension	2 week
• One-way Slab	3 week

References of first term

- Reinforced Concrete: Mechanics and Design, 4th Edition James G. MacGregor, James K. Wight, Prentice Hall, 2005.
- Design of Concrete Structures, 13th Edition Arthur H. Nilson, David Darwin, Charles W. Dolan, McGraw-Hill, 2003.
- Reinforced Concrete: A Fundamental Approach, 5th Edition Edward G. Nawy, Prentice Hall, 2005.
- Building Code Requirements for Structural Concrete, ACI318-05, American Concrete Institute, 2005.

WARNINGS

1) Study in groups but submit work on your own
2) No Copying of homework
3) Submit homework at the right place and time
4) Late homework with penalty 30%

Chapter One

1.1. Introduction

Concrete and its cementatiuos (volcanic) constituents, such as pozzolanic ash, have been used since the day of the Greeks, the Romans, and possibly earlier ancient civilizations.

To understand and interpret the total behavior of a composite element requires knowledge of the characteristics of its components. Concrete is produced by the collective mechanical and chemical interaction of a large number of constituent materials. Hence a discussion of the function of each these components are vital prior to studying concrete as a finish product. In this manner, the designer and materials engineer can develop skills for choice of the proper ingredients and so proportion them as to obtain an efficient and desirable concrete satisfying the designer's strength and serviceability requirements.

1.2. Concrete Components

1.2.1. Portland Cement

Portland cement is made of finely powdered crystalline minerals composed primarily of calcium and aluminum silicates. The addition of water to these minerals produced a paste that, when hardened, become of stonelike strength

1.2.2. Water

Water is required in the production of concrete in order to precipitate chemical reaction with the cement, to wet the aggregate and to lubricate the mixture for easy workability. Normally drinking water can be used in mixing.

1.2.3. Aggregates

Aggregates are those parts of the concrete that constitute the bulk of the finished product. They comprise 60 to 80 % of the volume of the concrete and have to be so graded that the whole mass of concrete acts as a relatively solid, homogeneous, dense combination, with the smaller size as an inert filler of the voids that exist between the larger particles. Aggregates are of two types:

1. Coarse aggregate: gravel, crushed stone, of blast-furnace slag.
2. Fine aggregate: natural or manufactured used.

1.2.4. Admixtures

Admixture are materials other than water, aggregate, or hydraulic cement that are used as ingredients of concrete and that other added to the batch immediately before or during the mixing.

1.3. Properties of Hardened Concrete

The mechanical properties of hardened concrete can be classified as (1) short-term of instantaneous properties and (2) long term properties. The short term properties can be enumerate as (1) strength in compression, tension, and shear and (2) stiffness measured by modulus of elasticity. The long-term properties can be classified in terms of creep and shrinkage. The following sections presents some details of aforementioned properties

1.3.1 Compressive Strength

Depending on the type of mixture, the properties of aggregate, and the time and quality of curing, compressive strengths of concrete can be obtained up to 150 MPa or more. Commercial production of concrete with ordinary aggregate is usually in the range from 20 to75 MPa, with the most common concrete strengths in the range from 20 to 60 MPa. The compressive strength, $f'c$ is based on standard 15mm × 30 mm cylinders cured under standard laboratory conditions and tested at a specific rate of loading at 28 days of age

1.3.2. Tensile Strength

The tensile strength of concrete is relatively low. A good approximate for the tensile strength f_{ct} is $0.1f'c<f_{ct}<0.2f'c$. It is more difficult to measure tensile strength than compressive strength because the gripping problems with the testing machines. A number of methods are available for tension testing, the most commonly used method being the cylinder-splitting test.

For members subjected to bending, the value of modulus of rupture f_r rather than tensile splitting strength is used in design. The modulus of rupture is measured by testing the failure of plain concrete beams 15 mm square in cross section, having a span in 45 mm and loaded at the third points.

$f_r = 7.5(f'_c)^{0.5}$ *for normal-weight and normal-strength concrete.*

1.3.3. Shear Strength

Shear strength is more difficult to determine experimentally than the tests discussed previously because of difficulty in isolating shear from other stresses.

1.3.4. Stress-Strain Curve

Knowledge of the stress-strain relationship of concrete is essential for developing all the analysis and design terms and procedures in concrete structures. Figure 1.1 shows a typical stress-strain curve obtained from test using cylindrical concrete specimens loaded in uniaxial compression over several minutes.

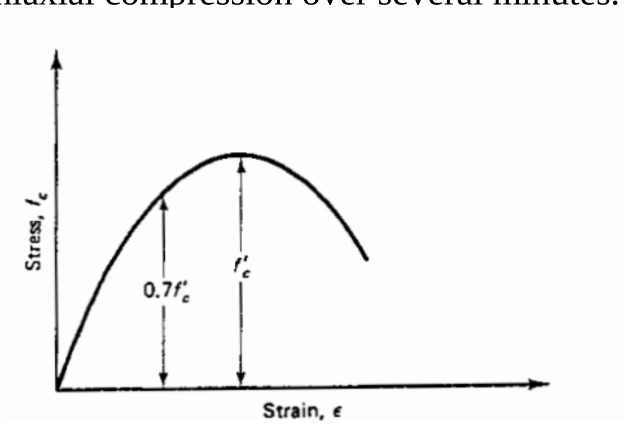

Figure1.1. Typical stress-strain curve of

1.3.5. Modulus of Elasticity

Young's modulus of elasticity can be applied only to the tangent of the cuve at the origin see Figure 1.2. The initial slope of the tangent to the curve is defined as the initial tangent modulus, and it is also possible to construct a tangent modulus at any point of the curve. The slope of the staight line that connects the origin to a given stess (about 0.4 f'_c) determine the secant modulud of elsticity of concrete. This value, termed in design calculation **modulus of elsticity**.

$E_c=4730(f'_c)^{0.5}$ For normal-strength concrete.

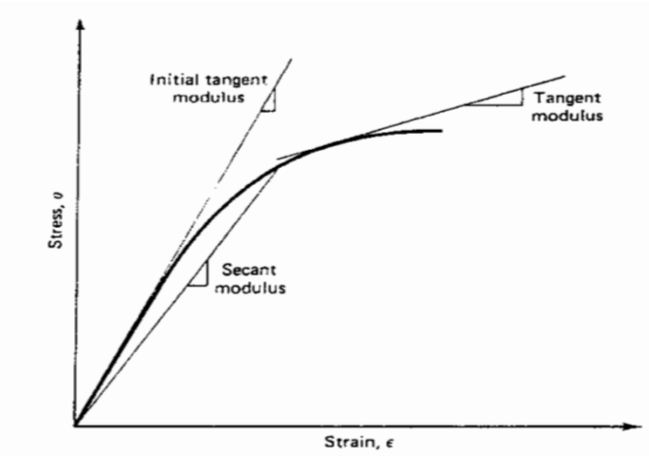

Figure1.2. Tangent and secant moduli of concrete.

1.3.6. Shrinkage

1.3.6.1. Plastic Shrinkage: occures during the first few hours after placing fresh in the form.

1.3.6.2. Drying Shrinkage: occures after the concrete has already attained its final set and a good portion of the chemical hydration process in the cement gel has been accomplished

1.3.7. Creep

Creep or lateral material flow, is the increase in the strain with time due to sustained load. Initial deformation due to the load is the elastic strain, while the additional stain due to the same sustained load is the creep strain.

1.4. Reinforced Steel

Concrete is strong in compression but weak in tension. Therefore, reinforcement is needed to resist the tensile stresses resulting from the induced loads. The most important properties of reinforcing steel are:

1. Young's modulus, E_s (see Figure 1.3.)
2. Yield strength, f_y
3. Ultimate strength, f_u
4. Steel grade designation

5. Size or diameter of the bar

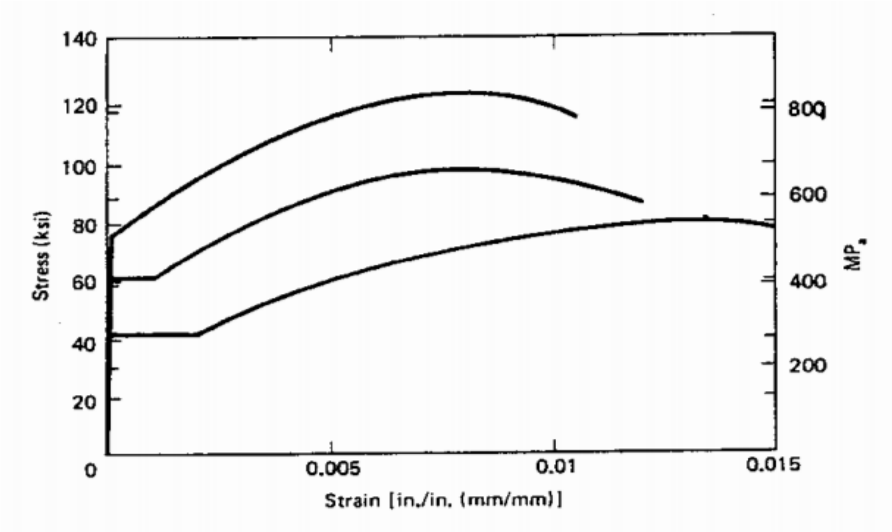

Figure 1.3.Typical stress-strain diagram for various steel.