THE UNIVERISTY OF ZAMBIA

School of Engineering

Department of Civil and Environmental

Engineering

CEE 3111 - CIVIL ENGINEERING MATERIALS AND CONSTRUCTION PRACTICES

2023 ACADEMIC YEAR

SEMESTER 1

TOPIC 4

Masonry

Introduction

- A masonry structure is formed by combining masonry units, such as stone, blocks, or brick, with mortar.
- Masonry is one of the oldest construction materials.
- Examples of ancient masonry structures include:
  - ✓ the pyramids of Egypt,
  - ✓ the Great Wall of China, and
  - ✓ Greek and Roman ruins

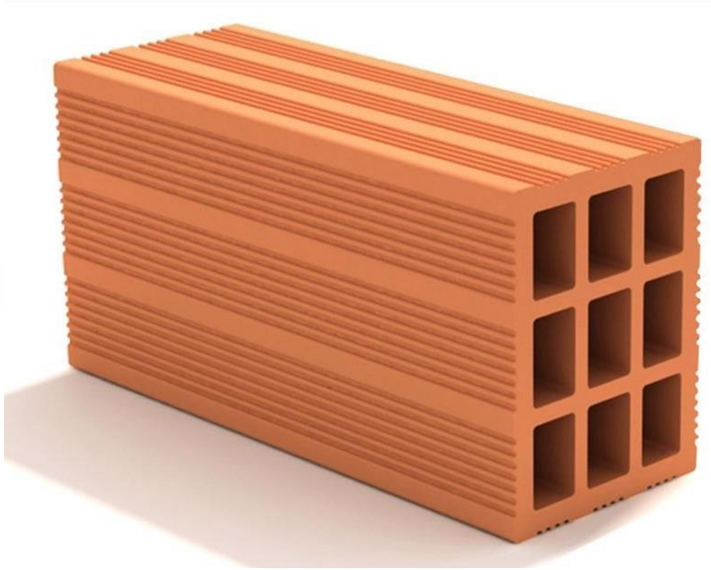
- Bricks have been used in constructing sewers, bridge piers, tunnel linings, and multistory buildings

- Masonry units are used worldwide and compete with wood, steel, and concrete for some uses.

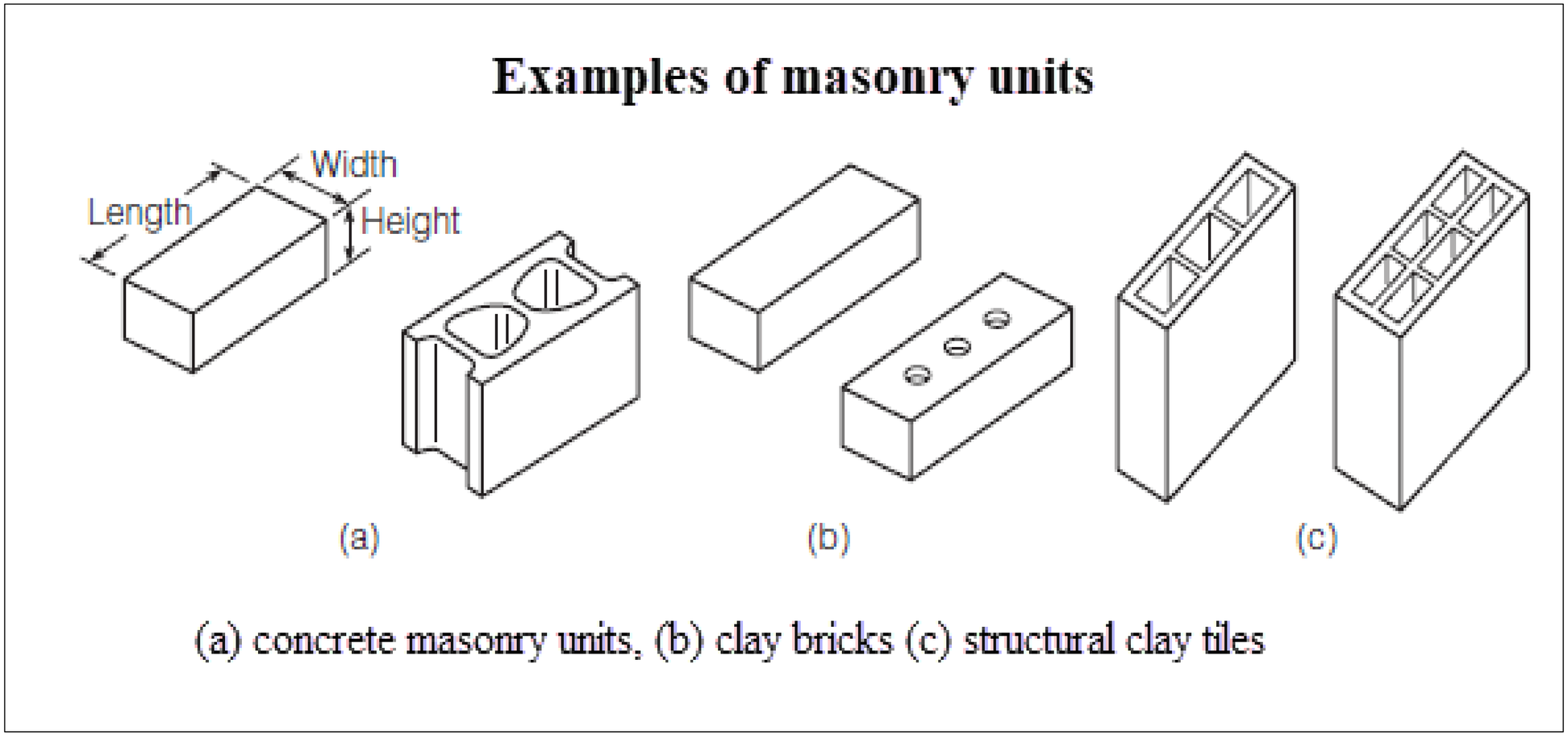
Classification of masonry units

- Masonry units can be classified as:
  - concrete masonry units
  - clay bricks
  - structural clay tiles
  - glass blocks
  - Stone
- Concrete masonry units can be either solid or hollow
- Clay bricks, glass blocks, and stone are typically solid.

- Hollow structural clay tiles are larger than clay bricks and used in structural and non-structural brickwork.



Classification of masonry units



(a) concrete masonry units, (b) clay bricks (c) structural clay tiles

Concrete Blocks

- Solid concrete units are commonly called concrete bricks, while hollow units are known as concrete blocks
- Concrete masonry units are manufactured in three classes, based on their density:
  - ✓ lightweight units,
  - ✓ medium-weight units, and
  - ✓ normal-weight units, with dry unit
- The dry unit weights for each class as shown below:

Weight Classification	Unit Weight Mg/m^3	Maximum Water Absorption kg/m^3 (Average of 3 units)
Lightweight	Less than 1.68	288
Medium Weight	1.68–2.00	240
Normal Weight	2.00 or more	208

Concrete Blocks

- Concrete masonry units are manufactured using a relatively dry (zero-slump) concrete mixture consisting of portland cement, aggregates, water, and admixtures.

- Type I cement is used to make concrete masonry. Type III is sometimes used to speed curing

- Air-entrained concrete is sometimes used to:
  - ✓ increase the resistance of the masonry structure to freeze and thaw effects and
  - ✓ improve workability, compaction, and molding characteristics of the units during manufacturing
- After manufacturing, the units are stored under controlled conditions so that the concrete continues curing.
- Concrete masonry units can be classified as
  - ✓ load bearing and
  - ✓ non–load bearing

Concrete Blocks

- The compressive strength of individual concrete masonry units is determined by capping the unit and applying load in the direction of the height of the unit until failure
- The gross area compressive strength is calculated by dividing the load at failure by the gross cross-sectional area of the unit.
- The net area compressive strength is calculated by dividing the load at failure by the net cross-sectional area.
- The net cross-sectional area is calculated by dividing the net volume of the unit by its average height.
- The net volume is determined using the water displacement method

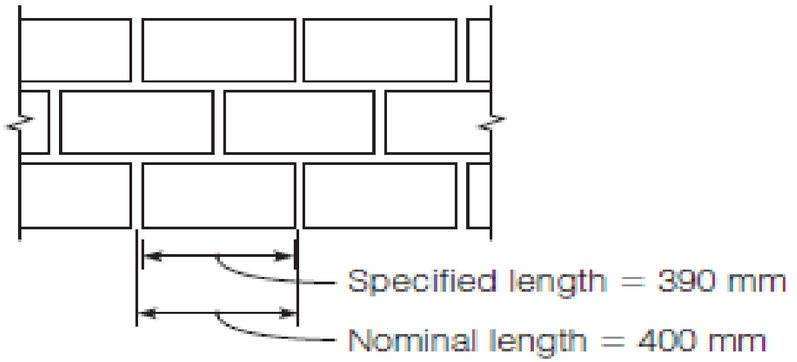
See Video on Materials Testing & Construction Concrete Hollow Blocks Test

Concrete Blocks

- Concrete masonry units are available in different sizes, colors, shapes, and textures.

- Concrete masonry units are specified by their nominal dimensions. The nominal dimension is greater than its specified (or modular) dimension by the thickness of the mortar joint, usually 10 mm

- For example, a 200 mm (8 in) * 200 mm (8 in) * 600 mm (16 in) block has an actual width of 190 mm, height of 190 mm, and length of 390 mm



Concrete Blocks

Load-bearing concrete masonry units are available in nominal widths of 100 mm, 150 mm, 200 mm, 250 mm, and 300 mm (4 in., 6 in., 8 in., 10 in., and 12 in.), heights of 100 mm and 200 mm (4 in. and 8 in.), and lengths of 300 mm, 400 mm, and 600 mm
(12 in., 16 in., and 24 in.)

Concrete Blocks

Example

A hollow concrete masonry unit has actual gross dimensions of 190 mm, height of 190 mm, and length of 390 mm. The unit is tested in a compression machine with the following results:

- ✓ Failure Load = 1112 kN
- ✓ Net volume = 6 x 10^6 mm^3

a. Calculate the gross area compressive strength.

b. Calculate the net area compressive strength.

Concrete Blocks

Solution

a. Gross area = 1*b = 390 * 190 = 74100 mm^2

$$Gross\ compressive\ strength = \frac{1112000\ N}{74100\ mm^2} = 15MPa$$

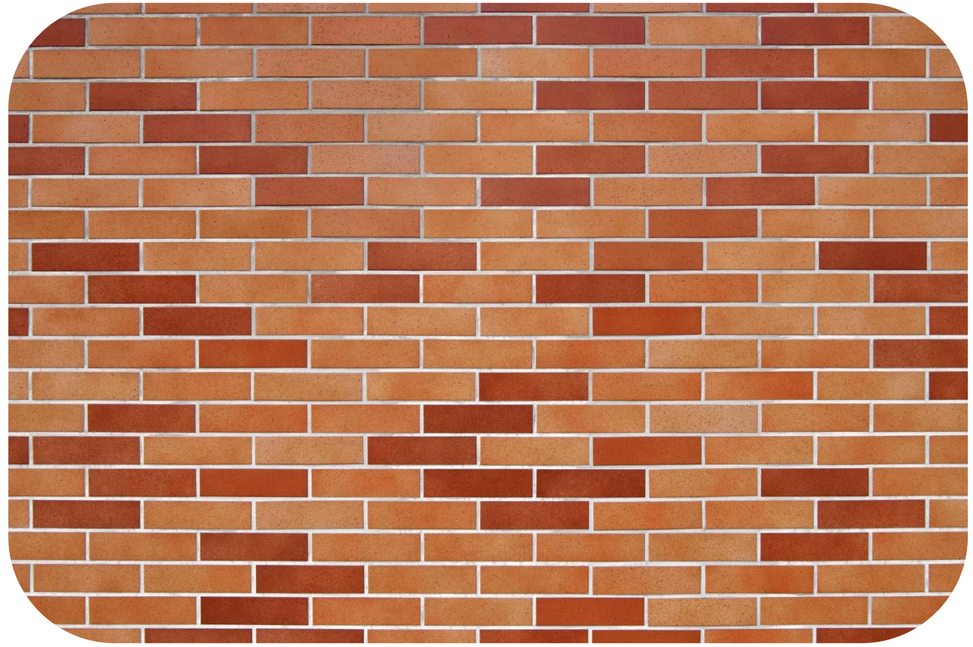
b. Net Area $= \frac{Volume}{Average\ Height} = \frac{6 \times 10^6 mm^3}{190\ mm} = 31600mm^2$

$$Net\ compressive\ strength = \frac{1112000\ N}{31600\ mm^2} = 35\text{MPa}$$

Clay Bricks

- Clay bricks are small, rectangular blocks made of fired clay.

- Clay bricks are used for different purposes, including:
  - ✓ Building – building bricks are common bricks used as a structural material, and are typically strong and durable
  - ✓ Facing and aesthetics - facing bricks are used for facing and aesthetic purposes
  - ✓ Floor making - floor bricks are used on finished floor surfaces, and are generally smooth and dense, with high resistance to abrasion, and
  - ✓ Paving – paving bricks are used as a paving material for roads, sidewalks, driveways, and interior floors.



Mortar

- Mortar is a mixture of cementitious material, aggregate, and water.
- Mortar can be classified as cement-lime mortar, cement mortar, or masonry cement mortar.
- Mortar is used for the following functions:
  - ✓ bonding masonry units together, either non-reinforced or reinforced
  - ✓ serving as a seating material for the units
  - ✓ leveling and seating the units
  - ✓ providing aesthetic quality of the structure

Mortar

- Mortar also needs to satisfy either proportion specifications or property specifications
  - ✓ proportion specifications specify the ingredient quantities
  - ✓ property specifications specify the compressive strength, water retention, air content, and the aggregate ratio
- Unlike concrete, the compressive strength is not the most important property of mortar.
- Since mortar is used as an adhesive and sealant, it is very important that it forms a complete, strong, and durable bond with the masonry units and with the rebars that might be used to reinforce masonry walls.
- The ability to bond individual units is measured by the tensile bond strength of mortar which is related to the force required to separate the masonry units.
- The tensile bond strength affects the shear and flexural strength of masonry

Grout and Plaster

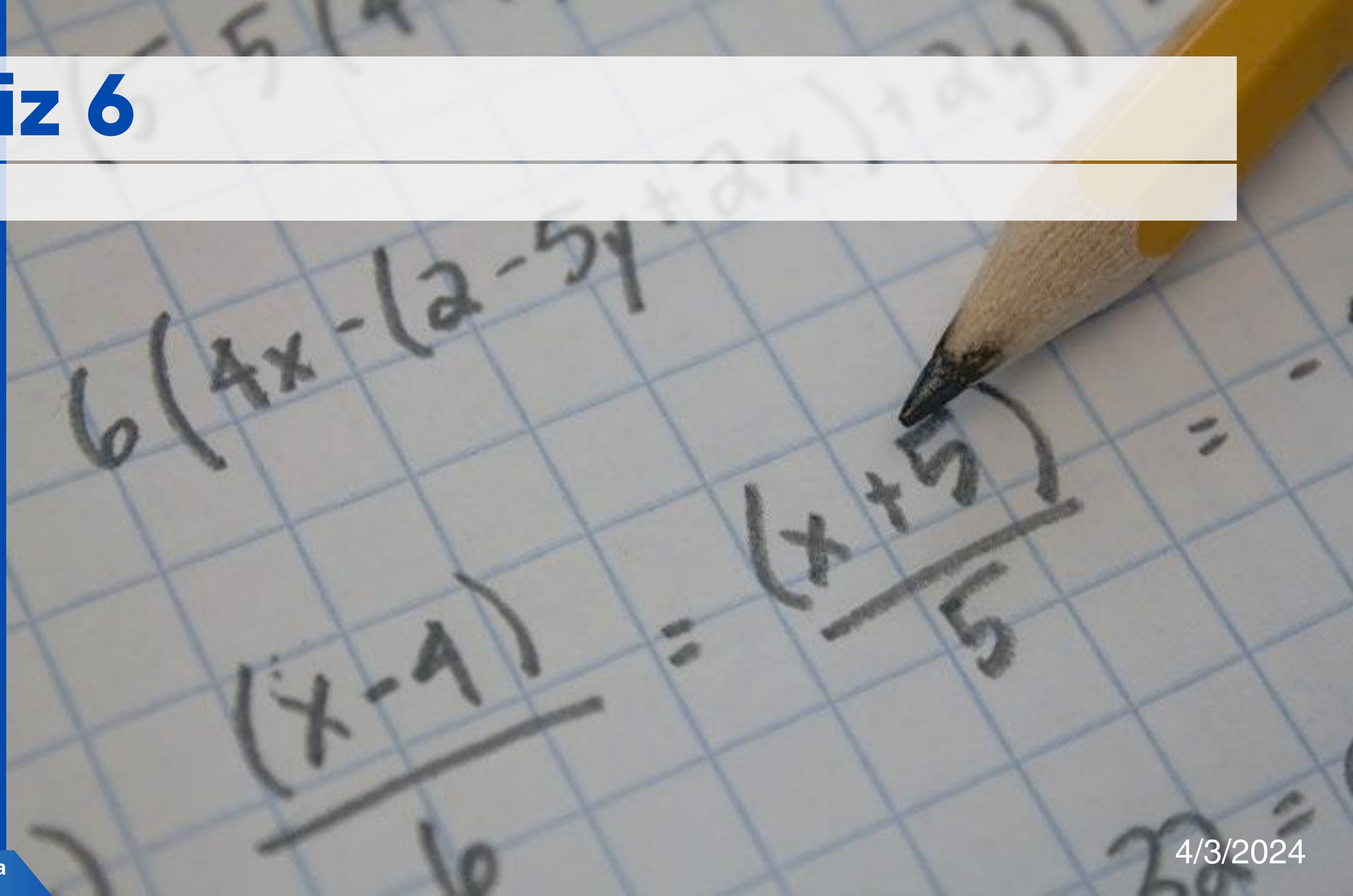
Grout

- Grout is a high-slump concrete consisting of portland cement, sand, fine gravel, water, and sometimes lime
- Grout is used to fill the cores or voids in hollow masonry units for the purpose of:
  - ✓ bonding the masonry units,
  - ✓ bonding the reinforcing steel to the masonry,
  - ✓ increasing fire resistance, etc

Plaster

- Plaster is a fluid mixture of portland cement, lime, sand, and water, which is used for finishing either masonry walls or framed (wood) walls. Plaster is used for either exterior or interior walls.

Quiz 6



Thank You!!!