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

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2023 ACADEMIC YEARSEMESTER 1

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Lectures: 2 Hours Per Week

Tutorials: 2 Hours Per Week

Labs: 3 Hours Per Week

Mondays: 08:00 - 10:00 Hrs

Thursdays: 08:00 - 10:00Hrs

Mondays: 14:00 - 17:00 Hrs

TOPIC 1

General Introduction to Civil Engineering Materials and Concepts

General Introduction

Material Engineers

- Responsible for the selection, specification, and quality control of materials to be used in civil engineering projects

General Introduction-cont'd

Critical material selection criteria

1. economic factors
2. mechanical properties
3. nonmechanical properties
4. production/construction considerations
5. aesthetic properties
6. sustainable development

General Introduction-cont'd

Selection of materials

- Consider the various criteria and make compromises

- Both the client and the purpose of the facility or structure dictate

General Introduction-cont'd

Commonly used materials in construction

- Traditional materials
  - ✓ steel,
  - ✓ aggregate,
  - ✓ concrete,
  - ✓ masonry,
  - ✓ asphalt,
  - ✓ wood

General Introduction-cont'd

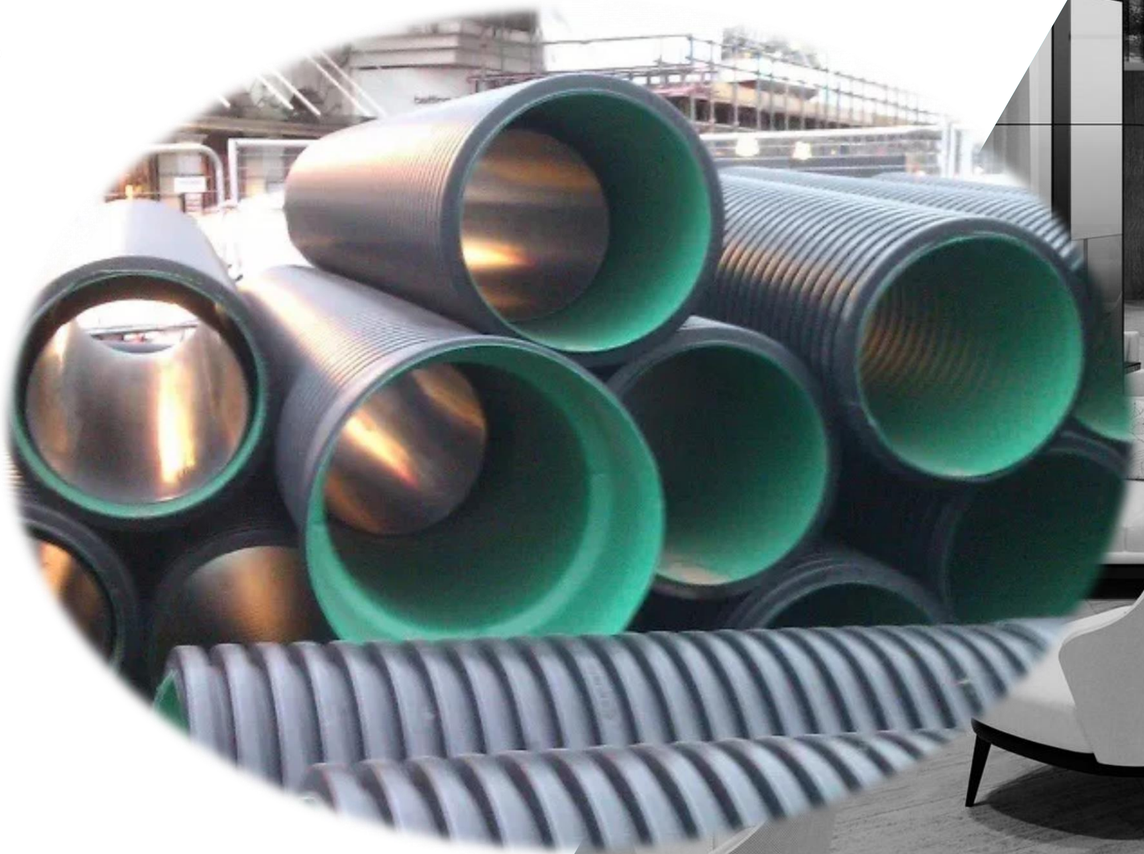
Commonly used materials in construction

- Others traditional materials include:
  - ✓ aluminum,
  - ✓ glass,
  - ✓ plastics,
  - ✓ fiber-reinforced composites

General Introduction-cont'd

Commonly used materials in construction

- High performance synthetic materials - better quality, more economical, and safer materials
- Examples include:
  - ✓ polymers,
  - ✓ adhesives,
  - ✓ composites,
  - ✓ geotextiles,
  - ✓ coatings,
  - ✓ cold-formed metals, and
  - ✓ various synthetic products



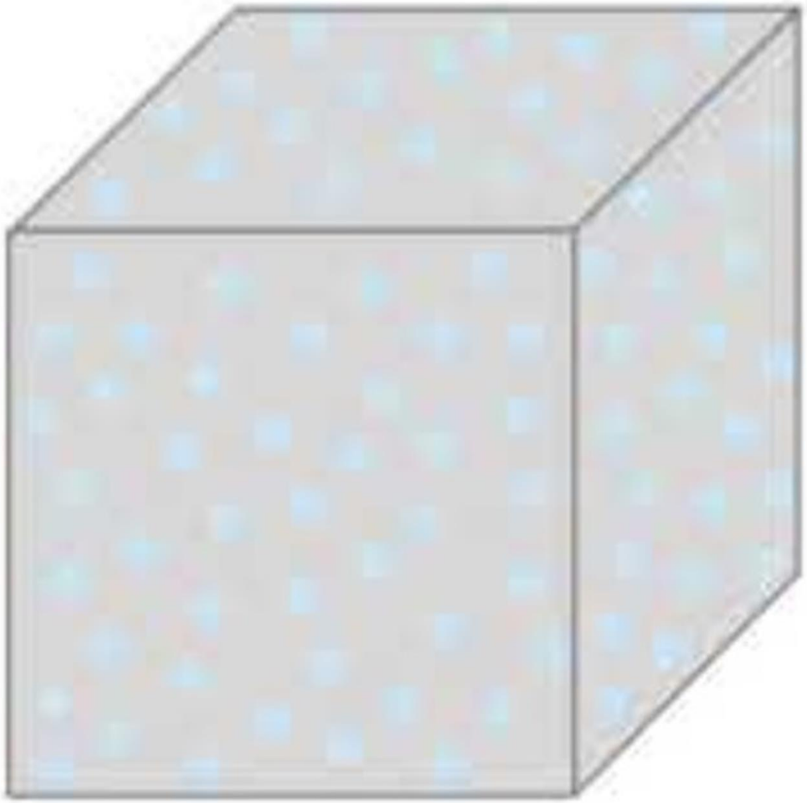
General Introduction-cont'd

Breakthroughs of high-performance materials

- **Superplasticizers** - are used in the concrete industry, allowing the production of much stronger concrete
- **Joints made of elastomeric materials** - have improved the safety of high-rise structures in earthquake-active areas
- **Lightweight synthetic aggregates** have decreased the weight of concrete structures, allowing small cross-sectional areas of components.
- **Polymers have been mixed with asphalt** - allowing pavements to last longer under the effect of vehicle loads and environmental conditions.

VODAPRUF

Lightherm aggregates



- ✓ No Floating
- ✓ Guarantee Blends Well
- ✓ No Additive Required

Economic Factors in Material Selection

Availability and cost of rawmaterials

Should be durable and readily available but inexpensive

Manufacturing costs

Construction materials should be easy to cut and shape with available tools

Transportation costs

Transportation can significantly add to the cost of the materials at the job site, and ultimately to the cost of a project.

Economic Factors in Material Selection

Placing

Materials selected for a job should enable ease of construction to reduce construction costs and time.

Maintenance

All materials deteriorate over time and with use but rate of deterioration varies among materials. Thus, when analyzing the economic selection of a material, the life cycle cost (LCC = Construction Cost + Operation and Maintenance Costs) should be evaluated

Mechanical properties in Material Selection

- Response of the material to external loads (both static and dynamic loads).

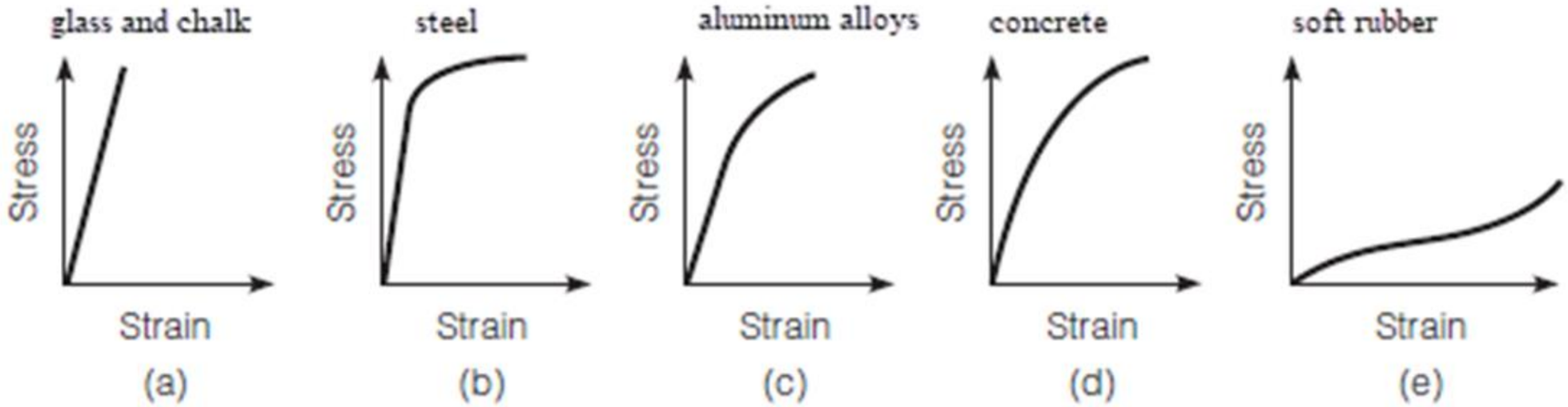
- Whether the material “fails” under the load conditions depends on the failure criterion
  1. **catastrophic failure** - recovery is impossible e.g. collapse of the structure

  2. **functional failure** - a structure is unable to function at expected level of performance.

- Elements considered include loading conditions, stress-strain relations, elastic behavior, temperature and time effect, etc.

Mechanical properties in Material Selection

Stress-Strain Relations



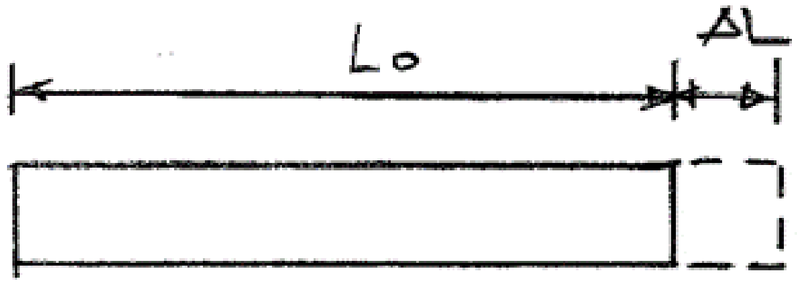
Stress-strain relations for common engineering materials:

Unit of stress

$$\sigma = \frac{Force}{Area} = \frac{N}{mm^2} = Mpa, where\ 1Mpa = \frac{1N}{mm^2}$$

Mechanical properties in Material Selection

Stress-Strain Relations



Normal strain; $\varepsilon = \dfrac{\Delta L}{L_0}$

For a homogeneous, isotropic, and linear elastic material, modulus of elasticity or Young's modulus, E is given by:

Young's modulus, $E = \dfrac{\sigma}{\varepsilon}$

Nonmechanical properties

- Density
- Thermal properties and
- Surface characteristics
  - ✓ Corrosion and degradation
  - ✓ Ability to resist abrasion and wear
  - ✓ Surface texture

Other material properties considered when selecting construction materials

1. Production and construction costs

2. Aesthetic Characteristics

3. Sustainable development

SAMPLE QUIZ QUESTION:

In your own words, define sustainable development with respect to selection of civil engineering construction materials.

Thank You!!!