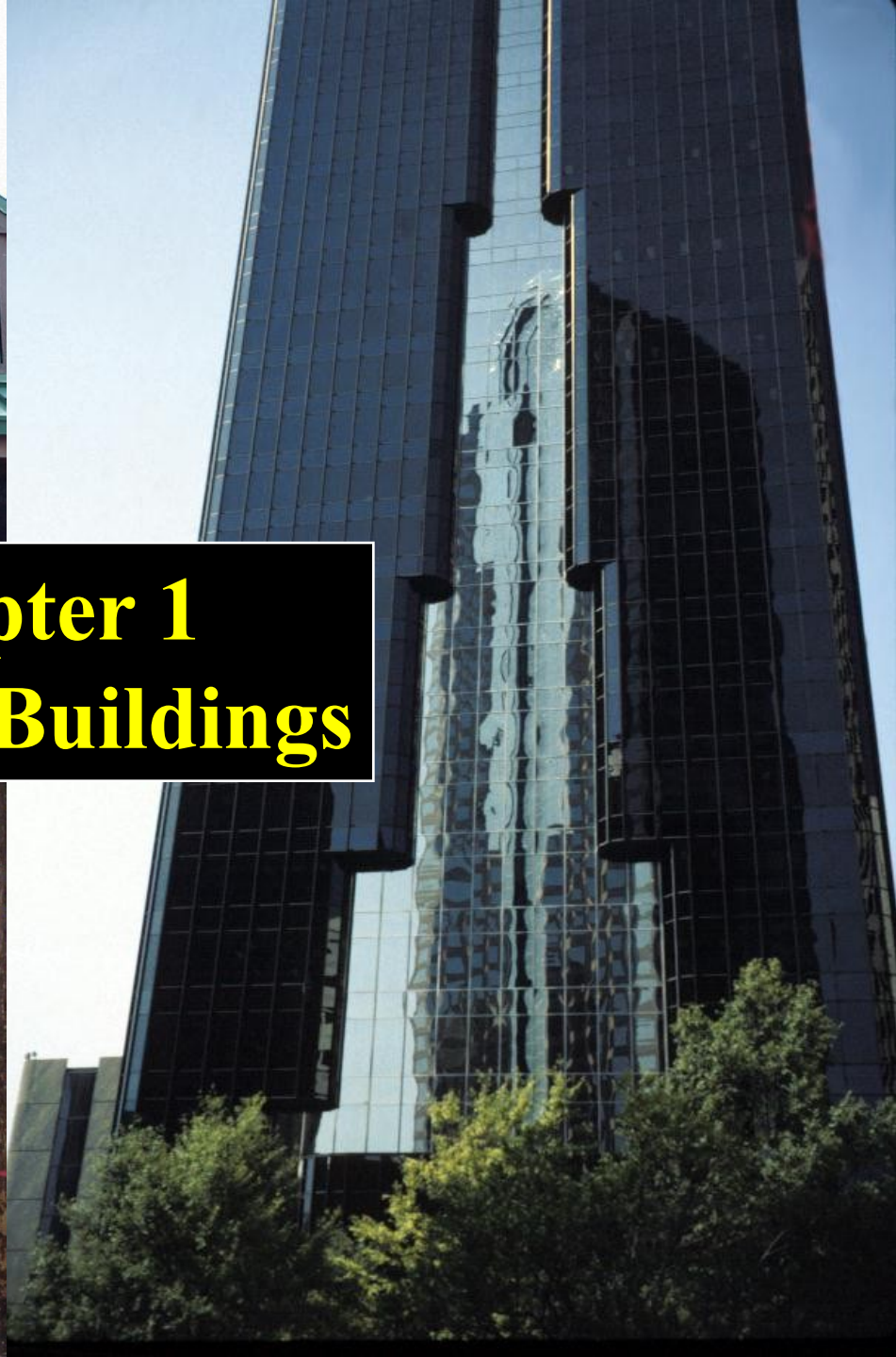
ENG 3731

Materials and Methods of Construction

1. INTRODUCTION TO MATERIALS AND METHODS OF CONSTRUCTION

1.1 Introduction to Materials and Methods of Construction

- **General introduction: syllabus, text book, laboratory classes and instruction sheets, assessment procedure**
- **Motivation for including this course in the civil engineering curriculum: Earlier course(s) in materials, continuing evolution of construction industry - (i) New building products such as composites, new grades of steel and concrete, new forms of construction (light gauge construction, glass technologies, etc); (ii) Changed social and political climate (construction workplace safety, environmental regulations, energy conservation in building, controlling codes of practice, etc.)**
- **Text book is rather challenging, to say the least - 330 typed pages, 491 pages of drawings and photographs, chapters of the book: Buildings, foundations, wood and construction, masonry and construction, steel and construction, concrete and construction, roofing materials, glazing materials, cladding systems, interior finishes, interior walls and partitions, ceiling and floor finishes, etc.**
- **Laboratory format - Five experiments - One experiment to be finished within the same day for the whole class - Three sittings in one afternoon.**



Chapter 1
Making Buildings

1.2 Making Buildings - Outline

- **Why do we need a building ? "Birds & animals", "Beast master", "Lost World", "Survivors" - Common link - We are not them**
- **Designing and making buildings : Stakeholders - "Sky is the limit", constraints to the choice of building systems - Codes, regulations, ordinances, unions, etc.**
- **How to choose a building system ? "Experience", "Pleasing to the eyes", "Economical", etc.**
- **Performance during and after construction**

1.2.1 Why do we Need Buildings?

- **. We need shelter from sun, wind, rain, and snow. We need dry, level platforms for our activities. Often we need to stack these platforms to multiply available ground space. On these platforms, and within our shelter, we need air that is warmer or cooler, more or less humid, than outdoors. We need less light by day, and more light by night, than is offered by the natural world. We need services that provide energy, communications and water and dispoWe build because little that we do can take place outdoorssal of wastes. So we gather materials and assemble them into the constructions we call buildings to satisfy these needs.**

1.3 Stakeholders in the Building Systems

- **Owner - Role ? Prime mover**
- **Architect - Selects the team of professionals - Develops the building concept in consultation with the owner - also carries out feasibility study**
- **Team of designers : Chemical, civil, electrical & mechanical engineers and naval architects ; draftsmen - Develop contract documents**
- **General contractor : Selects subcontractors - Begin construction**
- **Approving authorities and Compliance review**
- **Building inspectors, architect, and consultants - Compliance to design and code requirement**
- **"…for want of a nail the shoe was lost; for want of a shoe the horse was lost …."**

1.4 Constraints to Choosing Building Systems

- **General physical limitations: Land area available for building, weight of building and soil strength, structural dimensions, material performance under exposure conditions, contractual arrangements regarding building construction.**
- **Material selection dependent on: Designer/Architect with inputs from owner (for appearance and performance) and contractor (for cost, availability & constructability)**
- **Budget - Permitted and overruns**
- **Zoning ordinances: Imposed by local authorities (Planning Department - Residential or industrial, area covered by and offsets required for building, parking spaces, floor area, height of building, center-city fire zones, etc.**

1.4 Constraints to Choosing Building Systems (Cont'd)

Who is Primarily Responsible for Construction Methods?

AIA 201; The *contractor* shall be solely responsible for and have control over means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the contract (*unless instructed otherwise*)

1.4 Constraints to Choosing Building Systems (Cont'd)

- **Building Codes : "…. Establish minimum construction standards for the protection of life, health, and welfare of the public" - NBCC, IBC (2000), BOCA, SBC, ISO & EURO - Regulate the building activities - Define, natural light, ventilation, emergency exits, structural design, construction methodology, fire protection systems, accessibility to disabled persons, energy efficiency, etc.**

- **Occupancy Groups - Groups A-1 through A5 * Group B – Business Occupancy**
- **Group E – Educational * Groups H-1 through H-5 - High Hazard Occupancy**
- **Groups I-1 through I-4 - Institutional - Health care, geriatrics, prisons**
- **Group M – Mercantile - Stores (retail)**
- **Groups R-1 through R-4user groups, construction types, fire resistance ratings, materials - Residential Occupancies - Homes, apartments, dorms, etc.**
- **Group S-1 and S-1 - Hazardous storage * Group U – Utility Buildings**


Fire Wall

Building Regulations

- More than 44,000 jurisdictions in US regulating buildings
- Made > 12,000 amendments to the 3 model codes
- Differing standards and interpretation

Tuckman, J.L., ENR 7/23/2001

- Time required for permitting can be excessive:
  - EX Miami Dade:
    - » Each year reviews 120,000 – 130,000 applications, and performs > 1,000,000 inspections
    - » Average time required to issue a permit:
      - 52 days for residential
      - 81 days for commercial

Gonchar, ENR 7/30/2001

1.4 Constraints to Choosing Building Systems (Cont'd)

Health codes : Occupational health and safety

Fire codes

Plumbing codes

Electrical codes

Building Contractors' and Labor Unions' Regulations

- Who is Responsible to Ensure the Contract Documents Conform to Code Requirements?
- Why would the Architect have Primary Responsibility?
- Do contractors have any responsibility for code conformance?

Material Information Resources

- American Society for Testing and Materials (ASTM)
- American National Standards Institute
- US Bureau of Standards
- Construction Trade & Professional Associations
  (Technical specifications often incorporated by ‘reference’)

1.5 How to Choose a Building System?

- **Satisfy the requirements for functional performance: In stable equilibrium, Strength, Serviceability, Safety of operation**
- **Give the desired aesthetic qualities: Visual appearance, personal choice**
- **Not constrained by legal constraints: Codes & ordinances**
- **The most economical : Funds available, life-cycle costs, etc.**
- **Materials used are the most appropriate for the environment: least damaging and disruptive, very little environment damaging effluents and emissions, etc.**

Sustainability

- "…meeting the needs of the present generation without compromising the ability of future generations to meet their needs."

- **Sustainable Design & Construction Actions**
  - Energy efficient buildings
  - Re-use existing structures
  - Efficient land use
  - Use of renewable products / materials
  - Protect soil and water resources
  - Reduce / eliminate pollution
- **Sustainability - addressed on a Life Cycle basis**

- **SUSTAINABILITY CONSIDERATIONS WHEN SELECTING MATERIALS**
- Origin & Manufacture of Building Materials
  - Plentiful? Renewable? Recycled content? Energy expended to acquire? Manufacturing pollutants & waste?
- Construction of the Building
  - Energy expended to acquire & install? Pollutants generated? Waste generated & can it be recycled?
- Building Maintenance
  - Energy use over its lifetime? Material impact on indoor air quality? Maintenance required? Maintenance materials toxic? Recyclable? Fire & smoke properties?
- Demolition

1.6 Performance Before and After Construction

- **Performance Concerns :** **Building movements, structural deflections, thermal- and moisture- related expansion and contraction, heat flow, water vapor migration and condensation, deterioration, building maintenance, etc.**
- **Construction Concerns :** **Safety, built on time, within budget, quality of construction, sequencing of construction operations, inclement weather, quality assurance of materials, etc.**

1.7 Civil Engineering Materials in Newfoundland and Labrador

- www.gov.nf.ca/mines&en/mines/miningindustryoverview.htm
- Total value of mineral shipments from Newfoundland was $ 972 million during 2000
- Many of these commodities are critical elements in construction.
- Iron ore products and gold shipments are valued at $ 923 million- after primary processing
- Shipments of industrial minerals, or non-metals such as dolomite, silica, gypsum, dimension stone, peat and sand gravel are valued at $ 48 million - after primary processing
- Do we have other scopes than primary processing?
- Material produced : Limestone/dolomite, Dimension stone, Granite, Anorthosite, Peat, Slate, Iron ore, Gypsum, Silica
- Other developing products: Pyrophyllite, Talc, etc.

1.7 Civil Engineering Materials in Newfoundland and Labrador (Cont'd)

- **Most building materials are sold after primary processing**
- **Can we go to secondary processing? Paints - a viable industry in NL till 1988: ceased to exist due to takeover of industry - Components of paint : Vehicle (film-forming substance - Cellulose nitrate, vinyl chloride, polyurethane or epoxy resins), Solvents (water, hydrocarbons, turpentine, alcohols, ketones, ester, ethers, etc.) - Pigments (coloring agents - iron oxides (hematite, magnetite), chromium oxide, etc.)**
- **Additives: Defoamers (silicones), Driers and wetting agents (metallic soaps), flattening agents (talc, pyrophyllite).**
- **Almost all of them can be produced in Newfoundland**
- **What prevents us? - Practical problems**