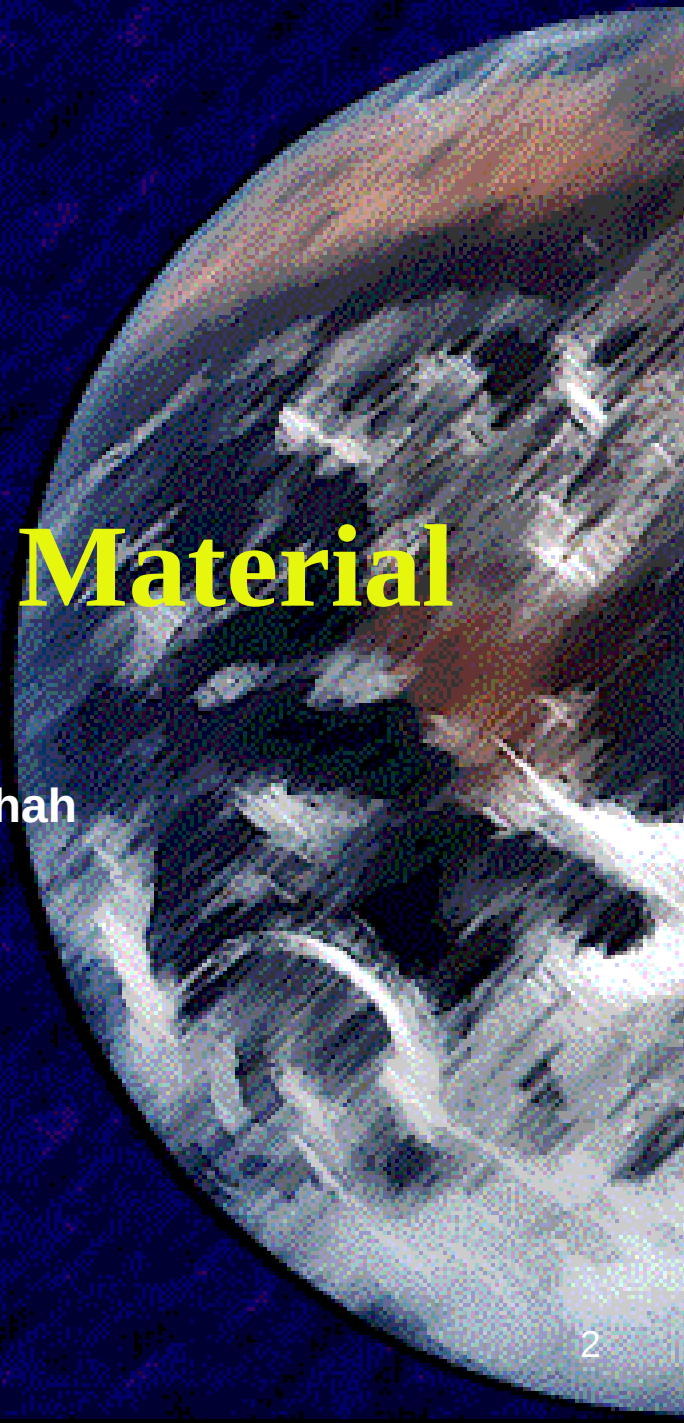

بسم الله الرحمن الرحيم

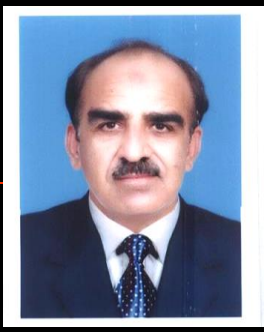
Civil Engineering Material

By

Engr. Prof. Dr. Attaullah Shah



Bio details



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    - +92-333-5729809, +92-51-9057212
- Qualification
- PhD Civil Engineering ,M.Phil Eco ,MSc Structure Engg
- MBA, MA Eco, MSc Envir Design,BSc Civil Engg (Gold Medal), Post Grad Dip Comp (Gold Medal)
- Teaching and Professional experience:
  - 25 Years
- Research Publications in refereed journals and conferences:
  - 25 Journals publicationsm+40 Conference publications
- Areas of interests
    - Structural Engineering
    - Sustainable built Environment
    - Construction project Management

Introduction- Course Objectives/ Course Learning Outcomes

- To familiarize students about the characteristics of construction materials used in civil engineering/ Knowledge of Properties of Civil Engineering material.

- To develop the skills for identification of suitable construction materials for civil engineering projects/Ability to develop to select appropriate Civil Engineering Material

Course Contents

- **Materials and properties:** Introduction of materials, Construction materials, Physical properties, Mechanical properties, Chemical properties, Electrical & Thermal properties Materials
- **Cement and Lime:** Introduction and manufacture of Ordinary Portland cement, Constituents of cement, Types of cement, Cement hydration, Properties and field tests of cement, Special cements, Introduction and manufacture of lime, Setting and hardening of lime, Applications of lime, Comparison of lime and cement.
- **Fine and coarse aggregates:** Definition and Introduction of aggregates, Mechanical properties of aggregates, Physical properties of aggregates, Importance and methods of grading of aggregates

- **Cementitious materials:** Introduction about mortars, Methods of preparation of mortars, Properties and application of mortars, Introduction about concrete, Components and manufacture of concrete, Properties of concrete, Types of concrete, Effects of various chemicals on concrete
- **Ceramics and Bricks:** History and evolution of ceramics, Manufacture of ceramics, Properties and applications of ceramics in buildings, History and evolution of bricks, Properties and applications of bricks, Brick dimensions, Manufacture and classification of bricks
- **Plastics:** Structure of plastics, Polymer technology, Types, Properties, Use of plastics as construction material
- **Glass:** Constituents of glass, Methods of manufacture, Types, Use and significance in civil engineering, Advantages and drawbacks

- **Wood:** Structure of tree, General characteristics, Types, Seasoning of wood, Preservation of wood, Lamination of wood
- **Paints:** Objectives, Composition, Types, Consideration in choosing a particular paint, Introduction, objectives and applications of varnish
- **Metals:** Introduction about metals, Non-ferrous metals: Aluminum, Copper, Zinc, Lead, Nickel, Ferrous metals: Iron, Cast iron and steel, Manufacture of steel, Types of steel, Heat treatment to steel, Hot and cold rolled steels, Stainless steel, Important failures in steels

- **Thermometry and acoustics:** Mode of Heat transfer in buildings, Thermal conductivity and diffusivity of building materials, Insulation in houses, Types of insulations, Acoustic insulation, Properties of good sound proof materials ,Noise Reduction Coefficients of building materials

- **Miscellaneous Construction Materials:** Asbestos, Plaster of Paris, Abrasives, Rubber , Cork, Bitumen, Asphalt, Road metal

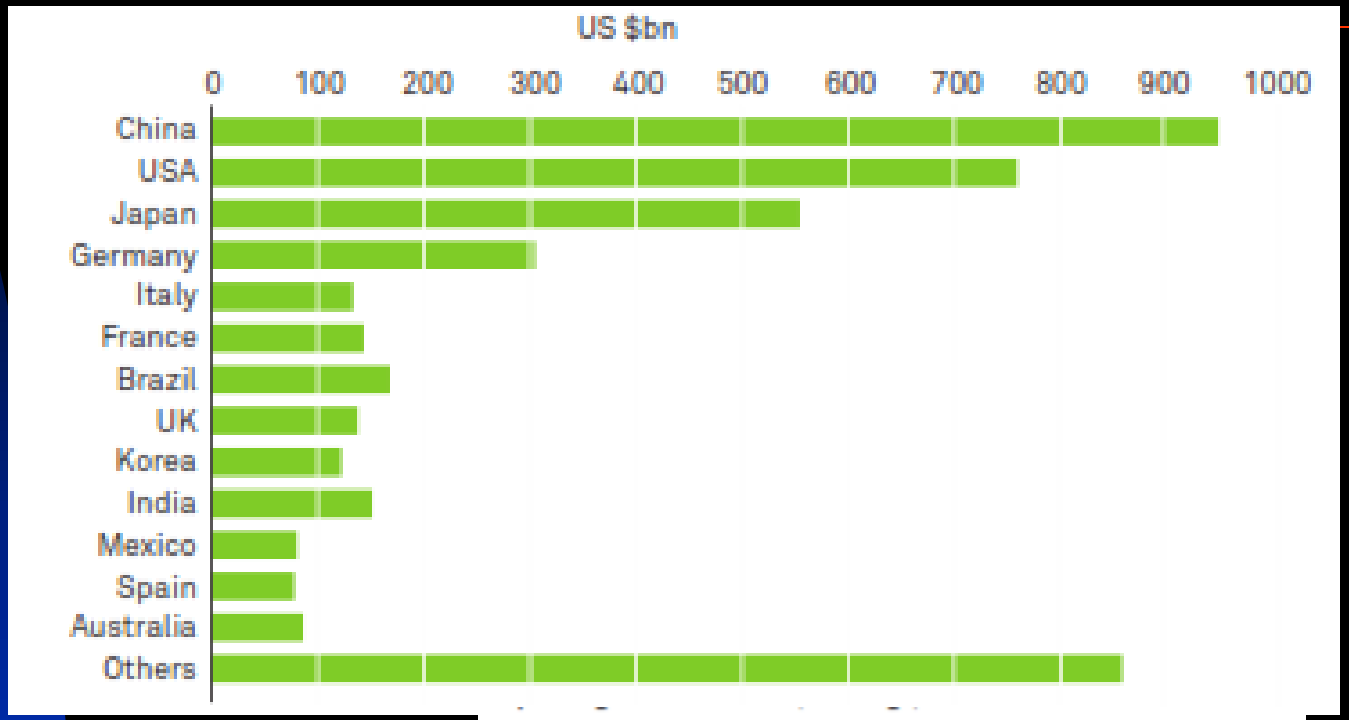
Purpose and quality of good building

- Provide Shelter- Comfortable, pleasant and healthy
- Well Designed building;
- Environment friendly
  - Resource Conservation;
    - Material conservation
    - Water conservation
    - Energy Conservation
  - Life Cycle Costing (Low Cost)
    - Pre-building (Design and Material selection)
    - During Construction
    - After Construction- Maintenance and repairs.
  - Humane (Human Friendly)
  - Low noise, Bearable thermal conditions,
  - Aesthetic (Visually pleasant)

Construction market in 2011-12

- Construction spending growth has stalled and 2011 was the fourth consecutive year with little or no growth (since 2007) .
- Overall, world construction spending grew by just 0.5% to $4.6 trillion and is still below the levels achieved in 2007.
- However, on a positive note, 2011 saw the first increases in world construction spending since the start of the recession.
- Although, the outlook for 2012-13 is looking slightly more pessimistic as the developing economies responsible for much of the growth in the recent past are starting to slow as their developed country export markets continue to decline.
- Asia and Latin America were the fastest growing regions in 2011 by a wide margin.
- For the second year running China was the largest market in 2011, and is forecast to be the fastest growing market in 2012-13

Global Construction spending 2011-12 and growth rate



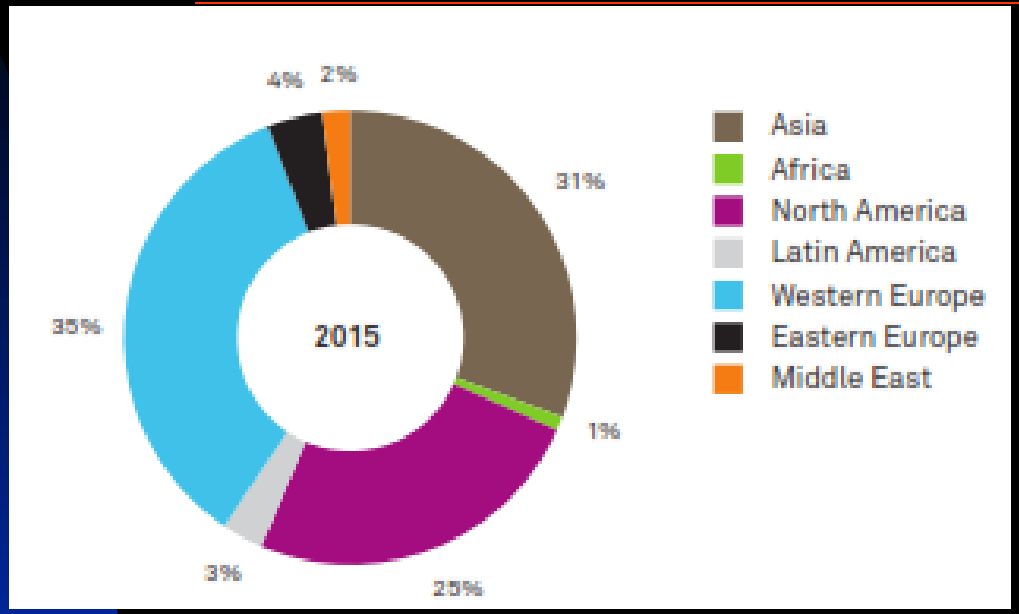
Impact of Construction Industry on National Economies

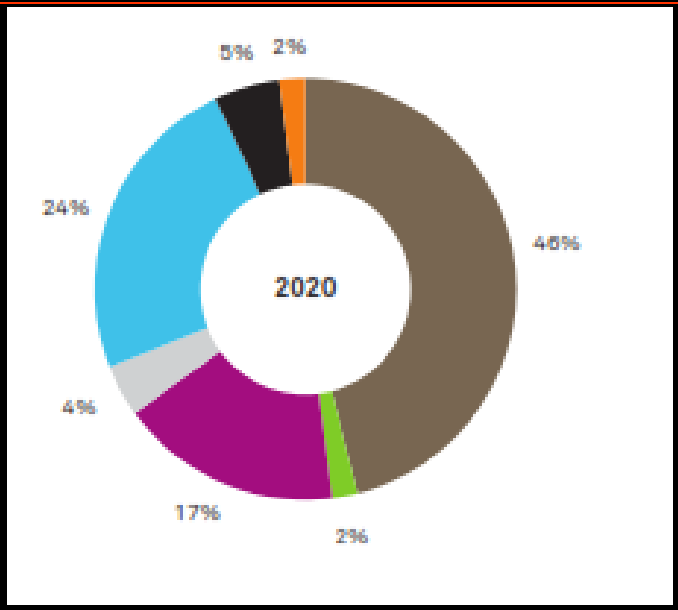
Country	Year	% of total value of goods and services or % of gross domestic product	% of total employment	% of total firms[1]
Australia	1997–1998	5.7	7.2	
Austria	1999	6.1	11.0	8.9
Czech Republic	1999	11.3	9.8	13.7
Denmark	1998			10.2
Finland	1999	8.5	8.8	12.5 (1998
Italy	1998	7.7	9.7	12.3
New Zealand	1998–1999		8.0	12.6
USA	1997	5.0	6.4	11.2
UK	1999	8.2	4.5 (1997)	11.2

[1] A firm is either a single business unit in a single location or a legal entity with one or more business units; country statistics use one definition or the other.

Sources: Organisation for Economic Cooperation and Development (2002); US Census Bureau (2000); Australian Bureau of Statistics (1999).

Global Construction Industry forecast.
Share of spending by region: 2015-20





- In the short term there is expected to be a degree of stagnation in global construction spending in 2012, with more sustained growth not expected until 2015 onwards
- Developing countries are expected to lead growth in 2012. The strongest construction spending growth will again be in China, followed by India and Indonesia

Construction industry segments

- Two very broad categories: - General building const
- - Engineered construction.
- **General Building Construction**
- Include residential, commercial, institutional and industrial buildings.
- **Residential construction produces buildings for human habitation, including single-family dwellings, condominiums, multifamily townhouses, flats and apartments and high-rise apartment buildings.**
- ***Commercial construction** includes retail and wholesale stores, markets and shops, shopping* **centers, office buildings, warehouses and small manufacturing facilities.**
- ***Institutional construction** are medical clinics and hospitals, schools and universities, recreational* **centers and athletic stadiums, governmental buildings and houses of worship and other religious buildings.**

Construction industry segments

- ***Industrial construction*** *is a* special segment of the industry that develops large-scale projects with a high degree of technical complexity.
- Such endeavors result in facilities that manufacture and process products; examples include steel mills, electric power-generating plants, petroleum refineries, petrochemical

  processing plants

- ***Engineered construction***
- This broad category of construction, sometimes called *engineering construction, is characterized* by designs prepared by engineers rather than architects, the provision of facilities usually related to the public infrastructure and thus owned by public-sector entities and funded through bonds, rates or taxes and a high degree of mechanization and the use of much heavy equipment and plant in the construction process.
- Examples: PSDP mega projects in Pakistan
- Two common subcategories of engineered construction are:

  -Highway construction and

  - Heavy construction.

Building Material

- Used for construction of buildings and Roads
- Classification based on source of material
  - Naturally occurring: Sand, aggregates, clay, timber, stones etc
  - Manufactured/ Modified: Established industry. Cement, tiles, pipes, steel bars etc.
- Classification based on use of material
  - Traditional: Naturally occurring substances;
    - Inorganic: Clay, stone, lime, gravels
    - Organic: Wood, bamboos,
  - Modern: synthetic material, plastics, petroleum based paints, blocks and bricks, concrete, metals, foams,
- Construction industry of the world one of the largest industry linked with more than 35 other industries.
- Construction material industry form major part of the industry

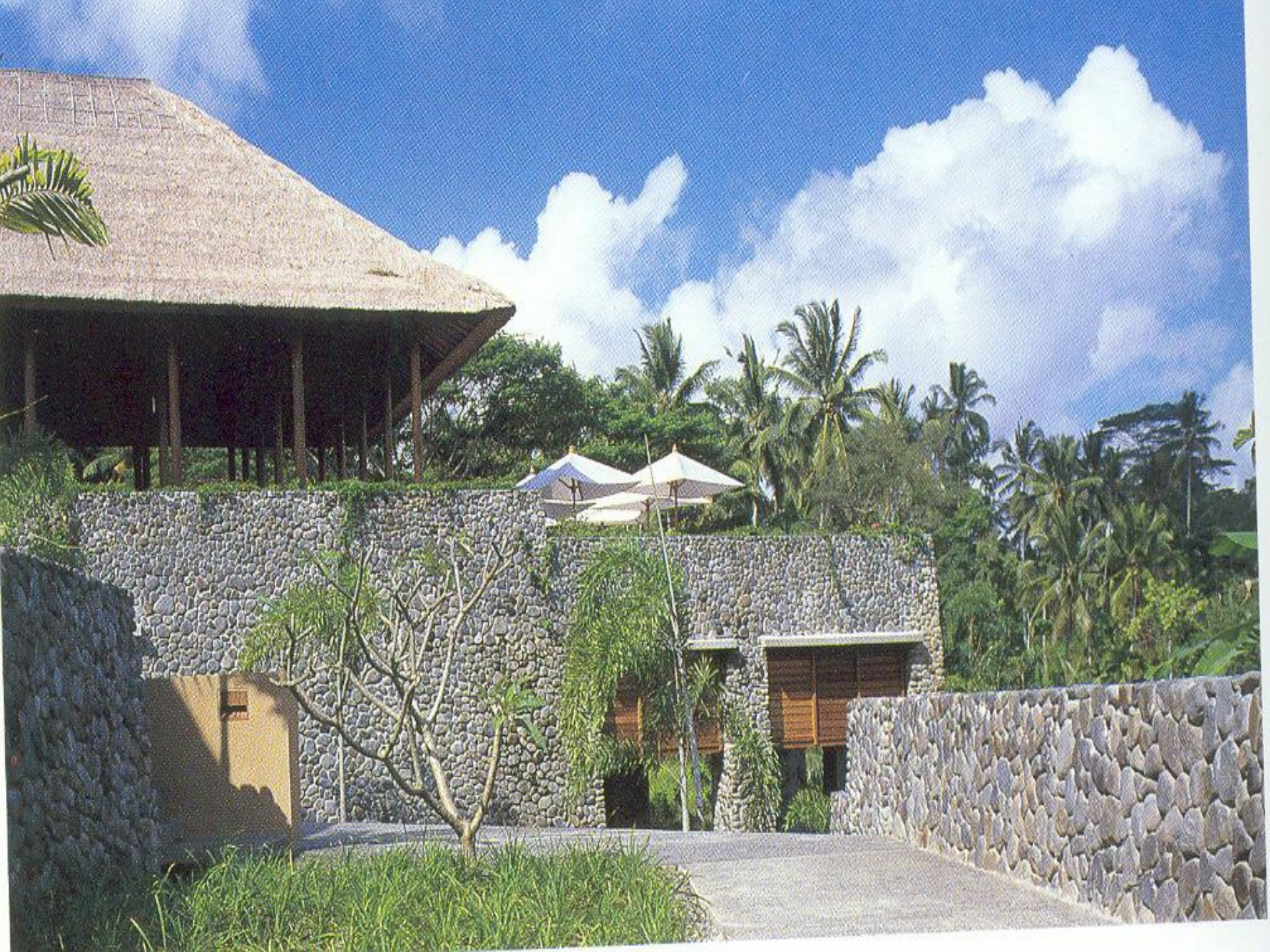

STONE WALL


86-A


Pizza del Arte


TOWN

WEATHERING ADDS BEAUTY TO LOCAL MATERIALS



CONCRETE

Concrete Choice

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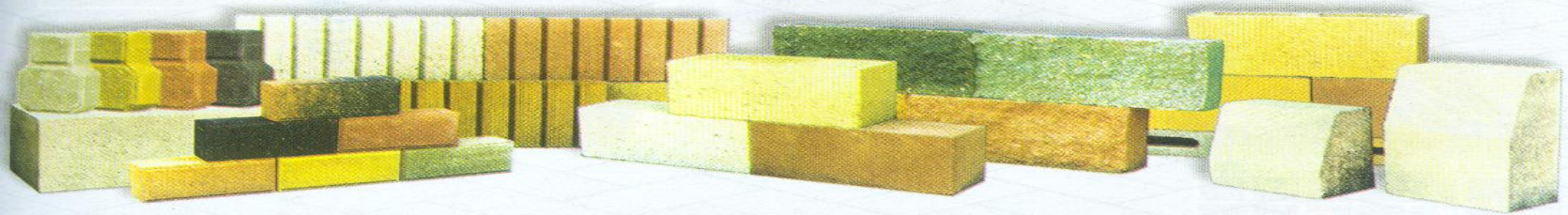

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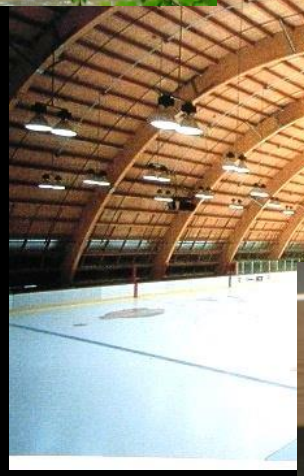
TIMBER

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GLASS


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PAINT

Building Materials


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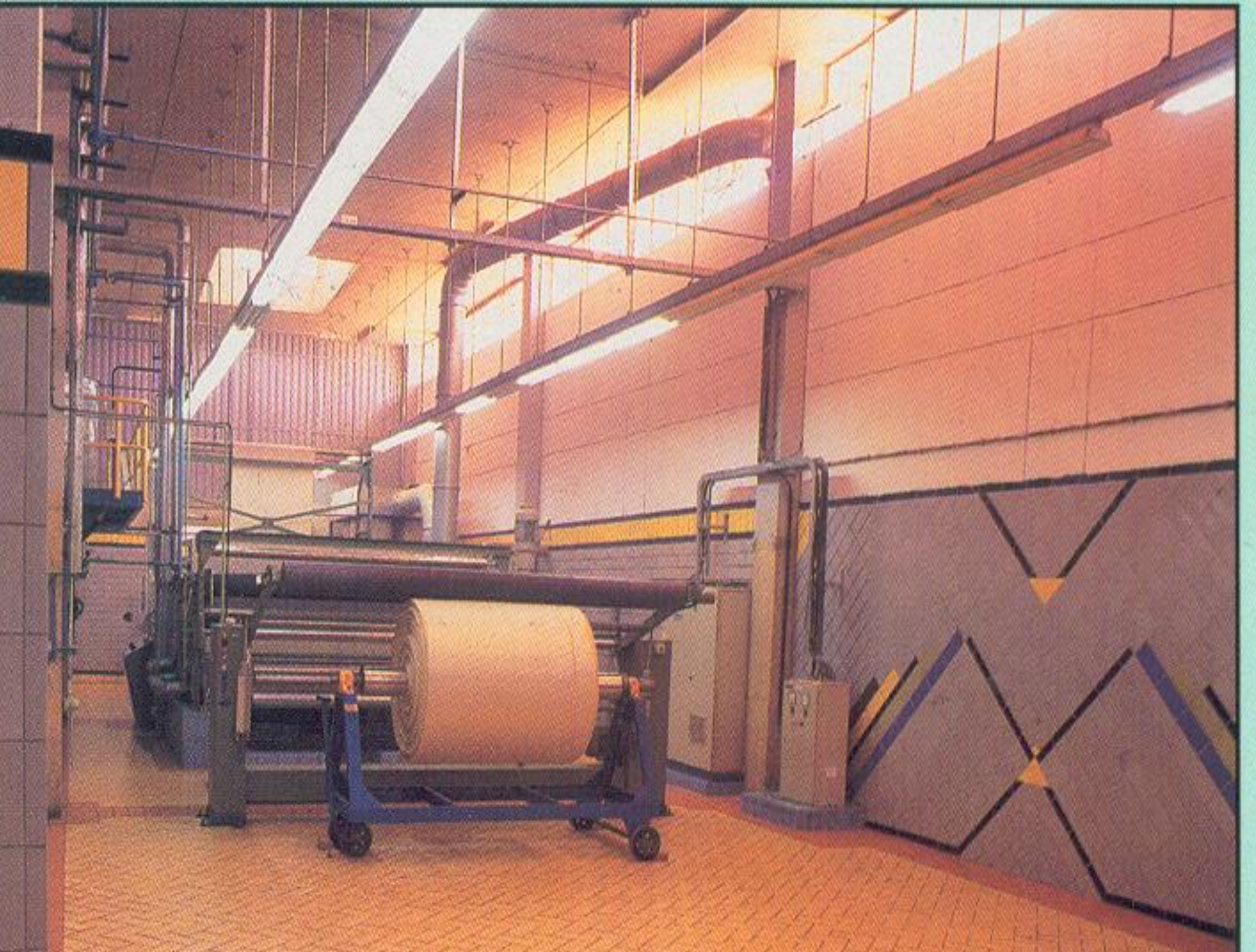
CERAMICS



MARBLE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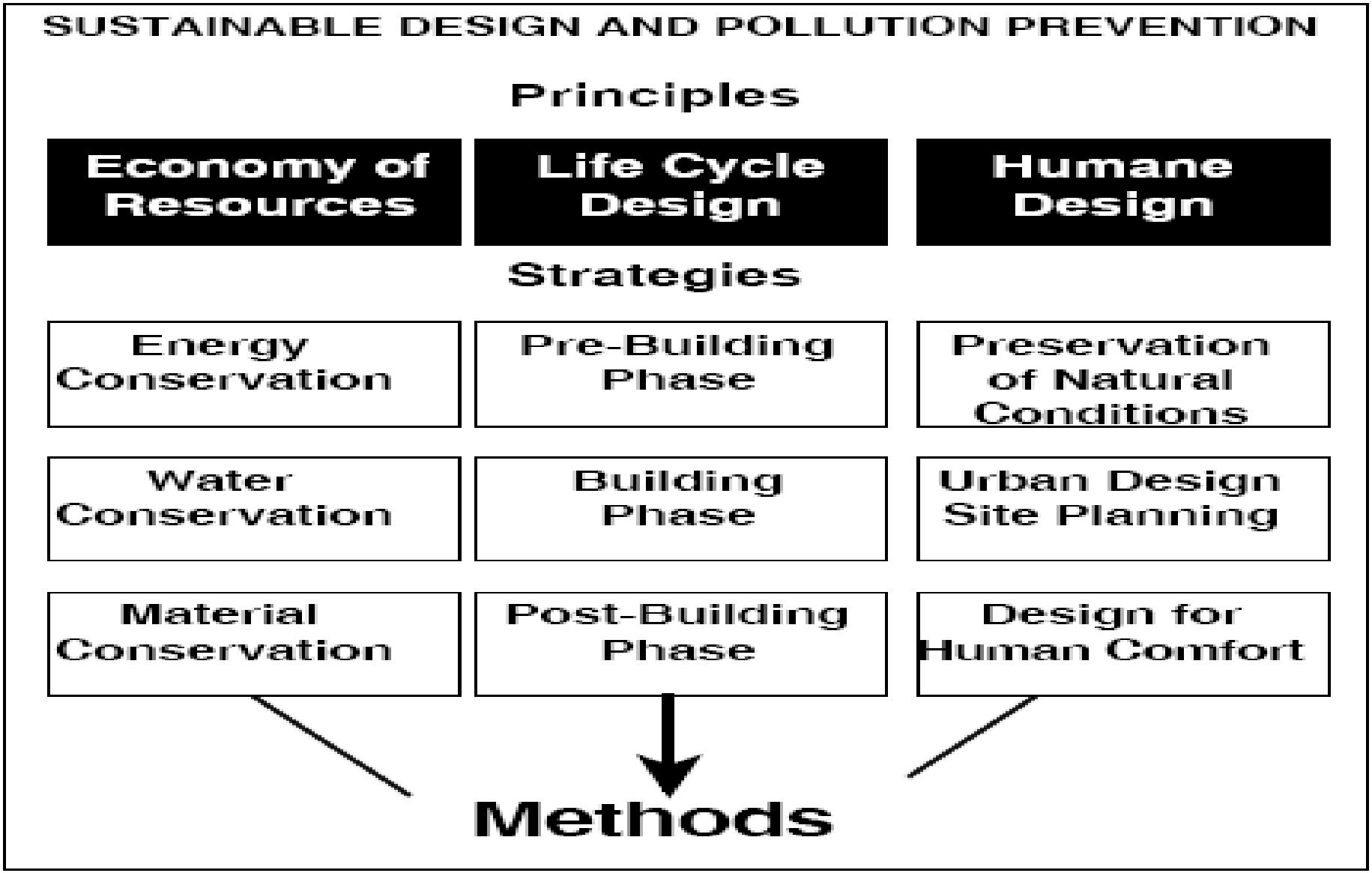
The Dilemma of Development

- Traditionally, we measure development in terms of Gross National Product (GNP), which favors any economic activities and production, regardless of their true benefits and effect on long-term societal well-being.
- In industrialized, capitalistic societies, consumption is regarded as a virtue.
- Development is creating depletion of natural resources, pollution, green house effects, global warming, climate change and many other menaces.

- Then How to develop? …… Through the Concept of Sustainable Development

The World Commission on Environment and Development has put forth a definition of “sustainability” as “meeting the needs of the present without compromising the ability of future generations to meet their own needs. **From *Our Common Future* London: Oxford University Press, 1987).**

Conceptual Model for Sustainable Design



General Properties of CE Materials

- Physical
- Mechanical
- Chemical
- Other
  - Thermal, Acoustical, Optical, Electrical

Most CE Applications focus on physical & mechanical properties

Physical Properties

- Properties of physical structure
  - Melting point and freezing point
  - density
  - specific gravity
  - porosity
  - Permeability
  - Thermal conductivity
  - Electrical Resistivity
  - surface energy
  - texture (micro, macro)
  - other (color, thermal expansion, shape)

Mechanical Properties

- Resistance to applied loads (stress) initially & over time
  - Stiffness: The property to resist deformations
  - Strength: The ability of metals to withstand various forces
  - Elasticity: The ability to regain its original shape and size after the removal of the loads.
  - Coefficient of Softening: The ratio of compressive strength of the saturated material to the dry state
  - Resilience: The work done to deform a material upto elastic limit
  - Hardness: The ability to resist abrasion, scratching and indentation by hard material
  - Ductility: Ability to elongate permanently under tensile forces.
  - Malleability: The ability to permanently extend in all directions when hammered.
  - Brittleness: The tendency to break suddenly when elongated
  - Creep: Slow deformation under long term sustained loads.

- Flexibility or pliability: The tendency to change shape under different stresses
- Fatigue: Repeated application/Cyclical load application and resultant stresses
- Toughness: The ability to get twisted, bent or stretched under high stress before rapture

Thermal Properties:

- Thermal Conductivity: The ability to transfer heat
  - Weight of the material
  - Porosity and Characters of pore
  - Moisture content
  - Mean temperature
  - Very important for material used in walls, panels, Glass claddings
- Thermal Capacity or Heat Capacity: The ability to hold heat
  - Closely related to weight of material
  - Used for calculating the thermal stability

Physiochemical properties of Building Material

- Hygroscopicity : Change in volume (Shrinkage and swelling) of the material due to moisture change
- Water absorption:
  - The ability to absorb and retain water

Metallurgical properties of building material

- Fusibility: Ability to become fluid when heated , usually takes place at melting point in metals
- Weldability: The ability to adhere firmly to the part of the same
- Hardening: The ability to become very hard when heated
- Tempering: Lowering the degree of hardness by heating and cooling repeadetly

Electrical Properties of CE Material

- Resistivity: The ability to impede flow of electricity
- Conductivity: The ability to allow current easily
- Dielectric Strength: The insulating capacity against high voltage
- Superconductivity

Determining the Properties of CE Materials

- Properties of materials are determined by
  - Laboratory testing
  - Field testing

- To avoid inconsistencies in test results **STANDARDS** are devised which describe the test apparatus and the procedure.

Items that are usually standardized in a test are:

- Obtaining test specimens and number of specimens
- Size and shape of the specimen
- Preparation of specimens for testing
- Temperature & moisture during preparation & testing
- Type of machinery
- Rate of loading
- Interpretation of test results
- Writing a report

Standardization Institutes

- Pakistan- Pakistan Quality Standards and Quality Control Organization (PQSQCA)
- Turkey - Turkish Standards Institute (TSE)
- England - British Standards Institute (BSI)
- Germany - Deutsche Institute Norm (DIN)
- U.S. - American Society for Testing and Materials (ASTM)
- Europe - European Committee for Standardization (CEN)
- Many More

Designation: C 28/C 28M – 00 (Reapproved 2005)

Standard Specification for Gypsum Plasters[1]

This standard is issued under the fixed designation C 28/C 28M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers four gypsum plasters; gypsum mill-mixed plaster, gypsum neat plaster, gypsum wood fibered plaster and gypsum gauging plaster.

NOTE 1—Specification C 842 contains application procedures for interior gypsum plaster.

1.2 The values stated in either inch-pound or SI (metric) units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. The values stated in each system shall be used independently of the other. Values from the two systems shall not be combined. This paragraph does not apply to the appendix.

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 The following safety hazards caveat pertains only to the test methods described in the appendix to this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 11 Terminology Relating to Gypsum and Related Building Materials and Systems

C 22 Specification for Gypsum

C 35 Specification for Inorganic Aggregates for Use in Gypsum Plaster

C 471M Test Methods for Chemical Analysis of Gypsum and Gypsum Products

C 472 Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete

C 778 Specification for Standard Sand

C 842 Specification for Application of Interior Gypsum Plaster

E 11 Specification for Wire-Cloth and Sieves for Testing Purposes

3. Terminology

3.1 *Definitions*—Definitions shall be in accordance with Terminology C 11.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *gypsum gauging plaster for finish coat, n*—a calcined gypsum plaster designed to be mixed with lime putty for the finish coat.

3.2.2 *gypsum neat plaster, n*—calcined gypsum mixed at the mill with other ingredients to control working quality and setting time.

3.2.2.1 *Discussion*—Neat plaster is either fibered or unfibered. The addition of aggregate is required on the job.

3.2.3 *gypsum mill-mixed plaster, n*—calcined gypsum plaster, mixed at the mill with a mineral aggregate, designed to function as a base coat to receive various finish coats.

3.2.3.1 *Discussion*—Other materials are not prohibited from being added to control setting time and other desirable working properties.

3.2.4 *gypsum wood-fibered plaster, n*—A calcined gypsum plaster in which wood fiber is used as an aggregate.

4. Materials

4.1 *Calcined Gypsum*—Calcined gypsum shall be manufac-

[1] This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.01 on Specifications and Test Methods for Gypsum Products.

Current edition approved Oct. 1, 2005. Published October 2005. Originally approved in 1920. Last previous edition approved in 2000 as C 28/C 28M – 00[ε1].

Designation: C 472 – 99 (Reapproved 2004)

Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete[1]

This standard is issued under the fixed designation C 472; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These test methods cover the physical testing of gypsum, gypsum plasters, and gypsum concrete.

1.2 The test methods appear in the following sections:

1.3 The values regarded as the standard are either in inch-pound units or SI (metric). The values stated first shall be regarded as the standard. Values following in parentheses are approximate and are provided for information purposes only.

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) are not requirements of the standard.

1.5 *This standard does not purport to address all of the*

C 11 Terminology Relating to Gypsum and Related Building Materials and Systems

C 778 Specification for Standard Sand

E 11 Specification for Wire Cloth and Sieve for Testing Purposes

3. Terminology

3.1 *Definitions:*

3.1.1 For useful definitions refer to Terminology C 11.

4. Precautions for Physical Tests

4.1 Gypsum products are greatly affected by small amounts of impurities introduced by careless laboratory manipulation. In order to obtain accurate results, it is absolutely essential to observe the following precautions:

4.1.1 Keep all apparatus thoroughly clean. Remove all traces of set plaster.

NOTE 1—For mixing pastes and mortars, a 500-ml rubber dental bowl is a convenience.

NOTE 2—Use care when drying gypsum, gypsum plasters, or gypsum concrete. Exceeding the specified drying temperatures may calcine the specimens, which will cause inaccurate test results.

5. Reagents and Materials

Continuous Assessment and Outcome Based Education

- No late coming allowed
- Only English Communication in class and University
- No home Assignment –Class based test every next week
- Group Assignment –Every next week
- Field Visits (Visit to Cement Factory etc.)
- Field Reports
- Case Studies /Research articles
- Practical and Lab reports
- Videos and other tools

Group Assignment-1:

- Please download the doc: " Qualities, Use, and Examples of Sustainable Building Materials"
  http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf
- Please study the doc and develop a write up and presentation on the following:
  - Gp-1: What is meant by Life Cycle Design and explain its components
  - Gp-2: What are essential elements of Pre-Design and Design phases for sustainable building design
  - Gp-3: What are essential elements of sustainable building material.
  - Gp-4: Describe criteria for selection of sustainable building material
  - Gp-5: Explain five major key building material and its source.

Some Suggestions

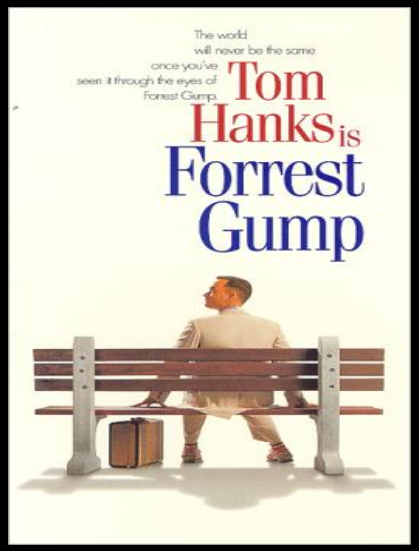
Work in groups.

Some Suggestions

Thou shall not wait till the last minute.

Exams

"Exam is like a box of chocolates; you never know what you are gonna get"



THANK YOU!