Skill Module – IV - AR 0401

MATERIALS AND ITS PROPERTIES

REFERENCE BOOKS

1. Rangwala S. C. – 1 Building Construction

2. Rangwala S. C. – 2 Engineering Materials

COURSE OBJECTIVE

Observing and analysing the role of materials and climate plays in the making of the form of select elements of a building.

COURSE CONTENT

Compiling & analysing various construction materials based on their availability, physical properties, cost and their construction techniques.

LEARNING OUTCOME

To gain better understanding and ability to analysis material and technology in response to climate and context.


MATERIAL DESIGN

Content

TIMBER

The wood used for structural purposes, building and carpentry. It is one of the oldest structural materials used by man which is versatile and used widely in construction. After the felling of trees the log is sawn in particular sizes depending on the use of the timber. Its limitations of transportation, available height, and span of the trees and which is available as hardwood and softwood in the market in different species and forms. Timber also requires seasoning and preservation for attaining its strength.

RAW MATERIALS/TYPES

Timber is available in different types in market such as log, deal, baulk, battens, boards, plank, end, scantling, pole, post.
All of them vary due to their shape, span and size .

SOFTWOOD	HARDWOOD
Obtained from: Coniferous trees, evergreen forests	Deciduous trees
Types of leaves: Needle shaped & light coloured	Broad leaved trees
Deodar (Himalayas)	Teakwood
Chir (Kashmir, Nepal, Sikkim, Pakistan)	Meranti (Southeast Asia)
Pine (USA, China, North America, Russia, Europe)	German chill (Germany)
Spruce (North america, Himachal pradesh)	Sudan teak (Sudan)
Douglas fir (California, Washington)	**Burma teak (Burma)**
New zealand pine (New zealand, Canada)	Ghana teak (Ghana)

Above all are available in ahmedabad

Cedar (Himalayas)	Alder (U.P., Nagaland)
Redwood (US, California)	Mahogany (Mexico and South America)
Juniper (Europe, North America)	Babul (Gujarat, Andhra Pradesh)
	Olive (USA, Rajasthan, Himachal, U.P.)
	[illegible]
	Cherry (UP, MP, J&K)
	Sal (MP, Odisha, Jharkhand)
	Ash (USA, Germany)

SIZE AND COST

Timber machined or planed is commonly reduced by 3mm for sections of 150mm or below, or 5mm for larger sections. Chir and Deodar are available in [illegible] and [illegible] is available in [illegible] and 1.20. **Most common grade** : 1416 cubic metre or more per year
Common grade : 356 to 1416 cubic metre
Less common Grade : less than 355 cubic metre or more
Price in Rupees per Cubic feet: Teak-1370-5000, Malaysian Teak-1100, Countrywood-400, Steam Birch-1000.

PROPERTIES

Moisture content in unseasoned timber is 25% or less. Seasoned timber has 10 to 15%. Partially seasoned timber has 15 to 25% moisture.
Thermal properties : Timber is natural barrier of heat. Lightweight timber is better insulator than the dense timber.
Modulus of Elasticity varies from 56 t/cm sq. to 125 t/cm sq.
Density varies from 550-750kg/cubic metre. **Tensile strength** of timber is between 70 to 140MPa while **Compressive strength** is 30 to 60MPa.

BUILDING USE

As structural component , used in making roof, columns, beams, planks, scaffoldings. Non-Structural use are furniture, model and ship making

fig.54 Different sizes of timber.

[illegible]

[illegible]

RAMMED EARTH

Rammed earth is a technique of constructing homogeneous walls by compacting wet mixture of clay, sand, gravel and silt in between a formwork. The wall is constructed in layers and the technique is majorly found in northern parts of India(Ladakh, Aravalli ranges), Russia, Brazil, Germany and some parts of The Great Wall Of China.

RAW MATERIALS

Inorganic sub-soil - Clay(5% - 20%)
Silt(10% - 30%)
Sand and gravel(45% - 80%)

Other materials like cement or lime are used as stabilisers. Sometimes, natural pigments are added to the mixture to get varied colours.

PROCESS OF MAKING

Rammed earth walls are made by first testing the inorganic sub-soil mixture and checking the proportions. Then adding the stabilisers to increase the strength in dry mix, then sprinkling water, breaking lumps and then, ramming the mixture layer by layer into the formwork.

SIZE AND COST

The maximum spanning of rammed earth walls is 1.5 to 2 m.
The cost of constructing a rammed earth wall per sq m is Rs 1500.

PROPERTIES

The U value(Thermal transmittance) for a 300mm thick rammed earth wall is 1.9-2.0 W/m2K. The R-value(Thermal resistance) for 300mm rammed earth wall is 0.50-0.70 m2K/W. It has good resistance towards fire as the mixture does not contain any flammable substances but as it is fully exposed to moisture, it needs protection from rain and long term resistance at the top and bottom of the walls.

BUILDING USE

It is used in constructing walls and for flooring.

fig. Rammed earth walls

fig. Using formwork for constructing the wall

fig. Rammed earth wall placed in between

FIRE KILN BRICKS

A brick is building material used to make walls, pavements and many other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote rectangular units made of clay-bearing soil and sand. It has a load-bearing potential.

RAW MATERIALS

Typical mixture :-
Black soil(70%), Sandy Soil(30%)
Water
Rice Husk
Ash

CLASSIFICATION

i) Process of making - a) Ground moulded b) Table moulded c) Wire cut
ii) Based on use - a) Facing bricks b) Backing bricks c) [illegible]
iii) Based on shape a) Frog b) Perforated c) Bull Nose d) Hollow
iv) Indian Standards - a) Class I b) Class II c) Class III

SIZE AND COST

		Cost	Compressive Strength
Standard Size	230 X 110 X 75 (mm)		
Other sizes	230 x 110 x 76 (mm)	Class I- Rs. 7-8/unit	105 kg/sq.cm.
	190 x 90 x 90 (mm)	Class II- Rs.5-6/unit	70 kg/sq.cm.
	215 x 100 x 55 (mm)	Class III- Rs.4-5/unit	35kg/sq.cm.

PROPERTIES

Thermal insulation High Resistance (K value-0.6W/mK)
Moisture Resistance Good (Value- 2.4 g/m²sPa)
Fire Resistance High Fire Resistance as during the process of making bricks are heated at around 2000 °C temperature.

BUILDING USE

Structural system- Load Bearing

Used in exterior for masonry work like structural walls, partition walls, column, also pavement

In interior as a cladding material and in flooring.

fig.31 Second class bricks, Chamber Brick manufacturer

fig.32 Centre for Habitat Studies, Architect Laurie Baker

fig.33 Brick Jali, Admun Design and Construction Studio

MILD STEEL

Steel is any alloy of iron and carbon, containing less than 1.5% of carbon. Because of its high tensile strength it is used in building tools, ships etc.

RAW MATERIALS

Iron ore
Coke
Lime Stone

PROCESS OF MAKING

Iron ore and coke are melted together in blast furnace and then solidified into rectangular shape, these are called billets. Hot rolling and cold rolling techniques can then be used to bring mild steel to desired size and shape.

Connections: Welding, Bolts, Rivets

MARKET SURVEY

Mild steel is available in different varieties in market.
For example - Ribbed bars, Twist bars, Flat bars, I section, T section, Corrugated sheet, Angle sections etc.
Length of the bars varies.
Bars are made in two ways. 1) Hot rolled 2) Cold rolled

SIZE AND COST

Sizes of Bars 4,5,6,8,10,12,16,20,25,28,32,36,40 mm
Cost is decided by weight
Cost
Twist bars 46 Rs./Kg.
Ribbed bars 40 Rs./Kg.

PROPERTIES

Tensile and shear strength is 40 to 60 kN/cm^2
Steel is inherently a noncombustible material. It loses strength when heated sufficiently
Steel does not expand or contract with moisture content.

BUILDING USE

Mild steel is used in many ways in building, as Beam, Column, Roofing, Flooring, Reinforcement, Cladding etc.

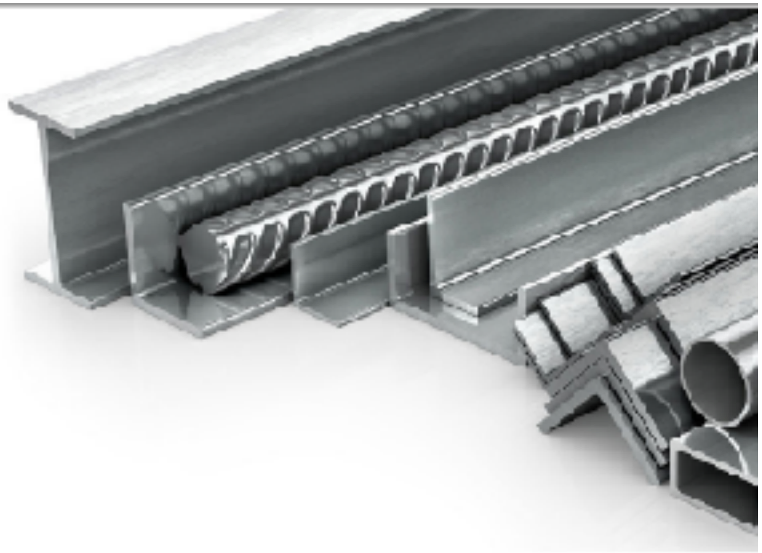

fig.27 Different types of steel sections

fig.28 Process

fig.29 House, Glenn Murcutt

PRECAST CONCRETE

Precast concrete is a construction element manufactured by prefabrication of concrete. These elements are fabricated in a reusable mould and transferred to the construction site for assembly.

RAW MATERIALS

Cement, Sand, Aggregates, Water and Steel

PROCESS OF MAKING

M.S. Steel moulds are used for form work, Steel wires are pretensioned or post tensioned into the mould. Mixture of Cement, sand, aggregates and water is poured into the mould. ratio of mixing is 1:2:3. Moulds are kept to dry for 18-24 hours in sunlight. To achieve its form, the moulds are removed after that and pre tensioned steel is cut by Welding machine. The finished element is kept under sunlight for 48 hours to obtain its maximum strength, water is sprinkled twice a day to prevent it from cracks.

SIZE AND COST

Column
Length 2740mm
Width 152 mm
Thickness 152 mm
Cost Rs. 60/sq.ft

Panels
Length 3120 mm
Width 304mm
Thickness 30, 35, 40, 45, 50 and 55 mm
Cost Rs. 35/sq.ft

PROPERTIES

Hardness 3000 Psi
Density 2400 Kg/m3
Flexural strength 400-700 psi
Tensile strength 300-700 psi
Grade: M5-M20

BUILDING USE

Structural and Cladding

Fig.35 Precast concrete shells, rafter and stilt used in Golconde, Puducherry

Fig.36 Aggregates

Fig.37 Sand