BUILDING MATERIALS,CONSTRUCTION PLANNING

Department of Civil Engineering

Prepared
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UNIT 1
INTRODUCTION

- NATURALLY AVAILABLE MATERIALS
- INDISTRIAL MATERIALS
- STONE
- BRICK
- LIME
- CEMENT
- METEL
- CERAMICS

INTRODUCTION

- TIMBER
- SAND
- AGGREGATES
- MORTAR

Naturally Available Materials

- Clay / Earth / Soil
- Wood / Timber
- Sand / Fine Aggregate
- Rock

Artificial Or Industrial Materials

- Cement
- Bricks
- Steel
- Tiles
- Ceramic
- Paints and Varnishes
- Glass
- Plastic
- Stone
- Lime

Stone

Requirements of Stone

- Structure
- Appearance-Colour Texture
- Weight
- Fineness of Grains
- Durability
- Strength
- Hardness
- Facility of Working and Dressing

Types of Stone

- Igneous Rocks, Sedimentary Rocks, Metamorphic Rocks.
- Stratified, Unstratified, Foliated.
- Siliceous, Argillaceous, Calcarious.

Uses of Stone

- They are used in hydraulic structures like dams and bridges.
- They are used in retaining wall masonry to retain soil.
- They are used as road metal in road construction.
- They are used as ballast for permanent way in railways.
- They are used to make concrete in the form of coarse aggregate.

Properties of Stone

- Silicious rocks are hard and durable. They are not easily affected by weathering actions.
- Argillaceous rocks may be dense and compact or they may be soft.
- The Durability of calareous rocks will depend upon the constituents present in surrounding atmosphere.
- Marble and quartzite have compact crystalline structure.
- Igneous rocks contain many minerals. Various minerals having wide range of different distinctive characteristics.

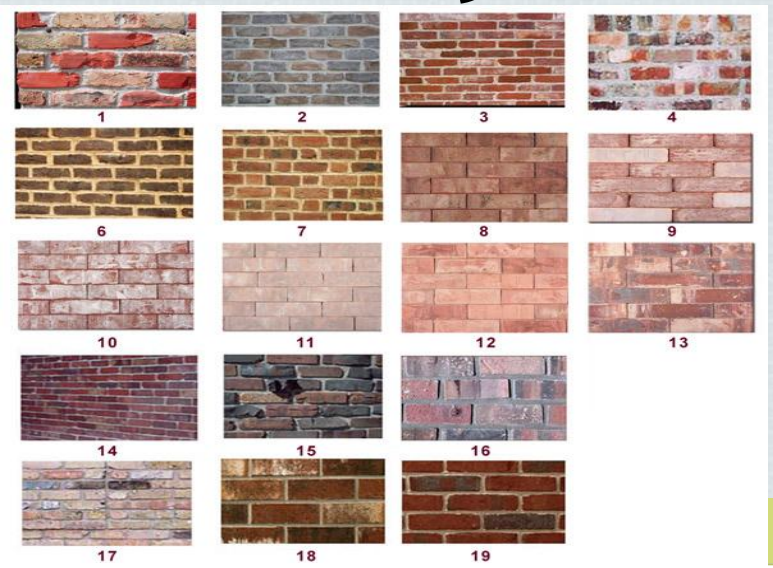
Brick

Requirements of Bricks

- The colour of the brick should be red or copper and uniform.
- It should be well burnt in kilns.
- The surface should be even and free from cracks.
- The edges should be sharp.

Types of Bricks

- Conventional / Traditional bricks : Size 23 cm x 11.4 cm x 7.6 cm
- Standard / Modular : Size : 19 cm x 9 cm x 9 cm



Uses of brick

- Bricks are used in wall masonry construction of building
- Used in brick lintal construction
- Bats of brick are used in concrete in foundation work

Properties of bricks

- They are durable.
- They are low cost material.
- They possess good strength.
- They are easily available.
- Brick are light in compared to stones.

Lime

Requirement of lime

- it should set easily.
- it should have low shrinkage.
- it should not contain impurities.
- It should be moisture resistant
- It should slake easily with water.

Types of lime

- Fat lime.
- Hydraulic lime
- 1)feebly
- 2)moderately
- 3)eminently
- Poor lime

uses of lime

- Lime is uses in the treatment of water and waste water.
- It is used in the manufacture of glass,refractory,sand lime bricks and paints.
- It is used as lime morter for mansonry work of buildings.
- It is used for plastering and white washing of buildings.
- It is used as lime concreat to make water proof stuctures.

Properties of lime

- It has good workability.
- It stiftens quickly.
- It has low shrikage.
- It has good resistant to moisture.
- Lime possesses good plasticity.

Cement

- **Requirements of cement**
- **Cement should Cement should not possess of alumina which may reduce strength.**
- **not contain alumina in excess as it weakens the cement.**
- **A very small amount of sulphur is added in cement to make sound cement.**
- **It should found cool when touch by hand.**
- **it should be in fine powder form while checking with first finger and thumb.**

Types of cement

- Ordinary portland cement(opc)
- Rapid hardening portland cement
- Quick setting cement
- Pozzuolana portland cement
- Low heat cement
- Blast furnace cement
- White cement
- Sulphate resisting cement
- Coloured cement

Uses of cement

- It is used in making joints for drains ,pipes.
- It is used to prepare RCC structures of building by using reinforcement with cement concrete.
- it is used in construction of buildings, bridges, tanks, domes, flyovers, dockyard etc.
- It is used to prepare cement mortar for building construction works like masonry, plaster, painting, flooring etc.
- It is used to prepare cement concrete for various construction works.

Properties of cement

- Physical properties of cement
- Mechanical properties of cement
- Chemical composition
- Fineness
- Soundness
- Setting of cement

Metal

Requirements of metal

- They should provide sufficient strength to bear the loads coming on them
- They should provide resistance to corrosion and weather actions
- They should provided resistance to heat and fire.
- They should have good adhesion with cement concrete.

Types of metal

- Ferrous metals
  1) pig iron
  2) cast iron
  3)wrought iron
  4)steel
- Non ferrous metals
  1) Aluminium
  2) copper
  3) Magnesium
  4) Nickel

Ceramics

- Requirement of ceramics
- They should provide resistance to stains
- They should be easy to clean
- They should be non- slippary while wet
- The colours of ceramic products should be long lasting
- They should be durable

Types of ceramics

- Crystalline
- Non crystalline
- Glass bonded

Uses

- Bricks
- Terra cotta
- Tiles
- Pipes
- Chimney

Properties of ceramic

- It has low ductility.
- It has low resistance to impact low toughness.
- It has excellent dielectric properties.
- It has good resistance to corrosion.
- It has good chemical resistance.

Timber

Requirements of timber

- It should be dense.
- It should have uniform texture.
- It should have dark uniform colour.
- It should be workable, good machinability.
- The medullary rays should be compact.

Types

- Natural timber

  babul, oak, pine, mango, sal, teak, neem, palms, chir.

- Industrial timber

  veneers, plywoods, fiberboards, impreg timber, compreg timber.

Uses

- Railway sleepers, bridges, pipes.
- Furniture, decorative pieces, doors.
- Packing material, piles, cart wheels.
- Poles, pen, rafter.
- Roofs, partition walls, boats etc.

Properties of timber

- It has low heat conductivity.
- It has small bulk density.
- It is relatively high strength.
- It is susceptible to decay.
- It is susceptible to flame.

Sand

Requirements of sand

- It should be clean.
- It should be well graded.
- Maximum permissible clay content is 3 to 4% in sand.
- It should contain sharp, angular grains.
- It should not contain salts which attract moisture from the atmosphere.

Types of sand

- Natural

  natural sand is obtained from pits, river beds and sea beds.

- Artificial

  artificial sand is formed by decomposition of sandstone due to various weathering effects.

Uses

- Sand is useful in various construction activities like masonry work, plaster work, flooring and concrete work.
- Sand is used in cement mortar, plan cement concrete , reinforced cement concrete and prestressed concrete as key ingradient in building construction

Properties of sand

- It is naturally available material
- It is durable
- It mix with binding material easily
- It has shiny luster
- It is of whitish brown colour.

Aggregates

Requirements of Aggregates

- Aggregates should be sufficiently strong.
- Aggregate surface should be rough and free form cracks.
- Aggregate should have good soundness.
- Aggregate should have good adhering with binding material.

Types

- Fine aggregates

  size of aggregate is 4.75 mm or less is termed as fine aggregates.

- Coarse aggregates

  size of aggregates 80mm to 4.75 mm is known as course.

Uses

- Fine aggregates are used to prepare cement mortar, lime mortar and cement concrete.
- Course aggregates are used to prepare cement concrete bituminous pavement, rigid pavement etc.
- They are used in construction of beams, columns, slab, lintel etc.

Properties of aggregates

- They are insoluble in water.
- They are of moderate weight.
- They are strong and durable.
- They have resistance to scratches.
- They have resistance to corrosion and decay.

Mortar

requirements of mortar

- It should have good adhesion with bricks, stones.
- It should resist penetration of rain water.
- It should be cheap, durable, and workable.
- It should be set quickly.
- The joints formed by mortar should not develop crecks.

Types

- As per type of binding material.

  like cement, lime, gauged, gypsum, surkhi.
- As per nature of application.
- As per density of the mortar.
- Spicial morter.

Uses

- To bind the bricks or stones firmly in wall construction work.
- They are used in plaster work as finishing material to provide weather resistance joints of masonry work are covered by plaster work. White wash and colour are applied on plastered surface easily.
- **Properties of mortar**
- Mobility.
- Place ability.
- Water retention

CONCRETE

- Concrete is a mixture of cement/lime, sand, crushed rock,water.
- Preparation of concrete

<1>Ingredient of concrete

<2>Methods of mixing of concrete

*TYPES OF CONCRETE

<1>Plain cement concrete

<2>Reinforced cement conceret

<3> Precast concrete

<4>prestressed concerte

PROPERTIES OF CONCRETE

- Workability
- Strength
- Durability
- Dimensional stability

USES

- Foundation to slabe in building
- Coating materil for water proofing

PAINT & VARNISHES

- The paints are coating of fluid materils and they are applied over the surface of timber and metal.
- The varnishes are transprent or nearly solution of resineous materials & they re applies over the painted surfaces.

TYPES OF PAINTS

- Aluminium paints
- Cement paint
- Asbestos paint
- Bituminous paint
- Emulsion paint
- Oil paint
- Plastic paint
- Synthetic ruber

PROPERTIES OF PAINT & VARNISH

- They are available in wide range of variety.
- They are speaded & strached as a layer on base by brushes.
- They are transparent
- They provide shine on old & new wood work.

REQUIREMENT OF PAUNT & VARNISHES

- The paints applied on a surface should dry within 24 hours.
- The paint should neither crack nor shrink after drying.
- The paint should have an attractive appearance.
- The colour of varnish should not develop cracks on drying.
- The varnish should adopt or accommodate to the expansion & contration of wood due to temperature varations.

GLASS

- Glass is an amorphuos,inorganic,homogeneous,transparent or translucent material.

TYPES OF GLASS

- Soda lime glass
- Potash lime glass
- Potash lead glass

PROPERTIES OF GLASS

- It can not deform.
- It is hard.
- It has resistance to scratches.
- It is brittle.
- It is affected by alkalies.
- It is transparent or translucent.
- It is no effect of air & water.

PLASTIC

- The plastic is an organic substance and it consists of natural or synthetic binders or resins with or eithout moulding components.

TYPES OF PLASTIC

<1>THERMO PLASTIC

<2>THERMOSETTING PLASTIC

PROPERTIES OF PLASTIC

- It is light in weight.
- Specific gravity of plastic is 1.40.
- They are low electrical conductivity.
- They are low thermal conductivity
- They can absorb shocks.
- USES
- To make waterproof doors,bags.
- To make furniture .
- To make optical lenses, frameas.

UNIT 2
Cement and Admixtures

What Are They?

- Ingredients other than:
  - Cement
  - Water
  - Aggregates
- Added before or during mixing.

Why Are They Used?

- To modify properties of fresh & hardened concrete
- To ensure the quality of concrete during mixing, transporting, placing & curing
- To overcome certain unexpected emergencies during concrete operations (ie, set retarders)

How Applied?

- Most admixtures are supplied in a ready-to-use form and added at plant or jobsite.
- Pigments and pumping aids are batched by hand in VERY small amounts

Effectiveness

- Factors effecting results of use:
  - Type & amount of cement:
    - Chemistry effects due to portland components
  - Water content & Slump
    - Flowability will effect how well admixtures are activated due to internal agitation actitivity
  - Mixing time
    - Effects of admixtures are dependent on time allowed to react.

5 Typical Functions of Admixtures:

- Air entraining
- Water-reducing
- Retarders
- Set Accelerators
- Plasticizers (superplasticizers)

- Some other “specialty” types exist:
  - Color, corrosion inhibitors, etc.

Air Entrainment

- Developed in 1930s
- Today, recommended for all concretes exposed to freeze/thaw cycles
- Imposes microscopic air cells that relieve internal pressure of freezing water
- Typical target air values are 5%-8%
- Will also increase slump (workability)

Master Builders Micro Air

- Performance:
  - Improved air void system
  - Improved workability & plasticity
  - Reduced permeability
- Dosage 1/8 to 1-1/2 oz per cwt of cement
  - Trial batch required to target air.

Water Reducers

- Internal lubricant
- Allows for reduction of water/cement ratio while maintaining workability (increased strength)
- Can reduce water requirement at least 5-10%
- Obtain higher slump without adding water
- *Mid-range* water reducers result in at least 8%
  - *Mid-range* water reducers provide more consistent setting times than standard water reducers.

Water Reducer: Pozzolith

- Performance:
  - Improves workability at low w/c ratio
  - Normal to retarded set times
  - Helps eliminate “cold joints”
- Dosage:
  - 4-10 oz per cwt of cement

Set Retarders

- Slows curing rate
- Used to counteract hot weather conditions that cause increased rate of hardening.
  - This makes placing and finishing difficult
- Pozzolith 961
  - Performance & dosage (see handout)

Set Accelerators

- Increase curing rate for achievement of high early strength
- Speeds up start of finishing operations
- Used for speeding curing rate in cold weather concreting
- Pozzolith 122
  - Performance & Dosage (see handout)

Master Builders Pozzolith

- Performance:
  - High early strength
  - Accelerated setting time characteristics
- Dosage: 16-64 fl oz/cwt (100 wt) cement
- Higher dosages increase acceleration rate

Superplasticizers

- Also known as *high-range* water reducers (HRWR)
- Reduce water requirement by 12-30%
- Can make low slump concrete flow like high-slump mix
- Makes mix highly fluid and can be placed with little or no vibration or compaction
- Effect lasts only 30-60 minutes and is followed by rapid loss of workability
- Usually added at jobsite

UNIT 3
PLUMBING SERVICES AND BUILDING COMPONENTS

INTRODUCTION

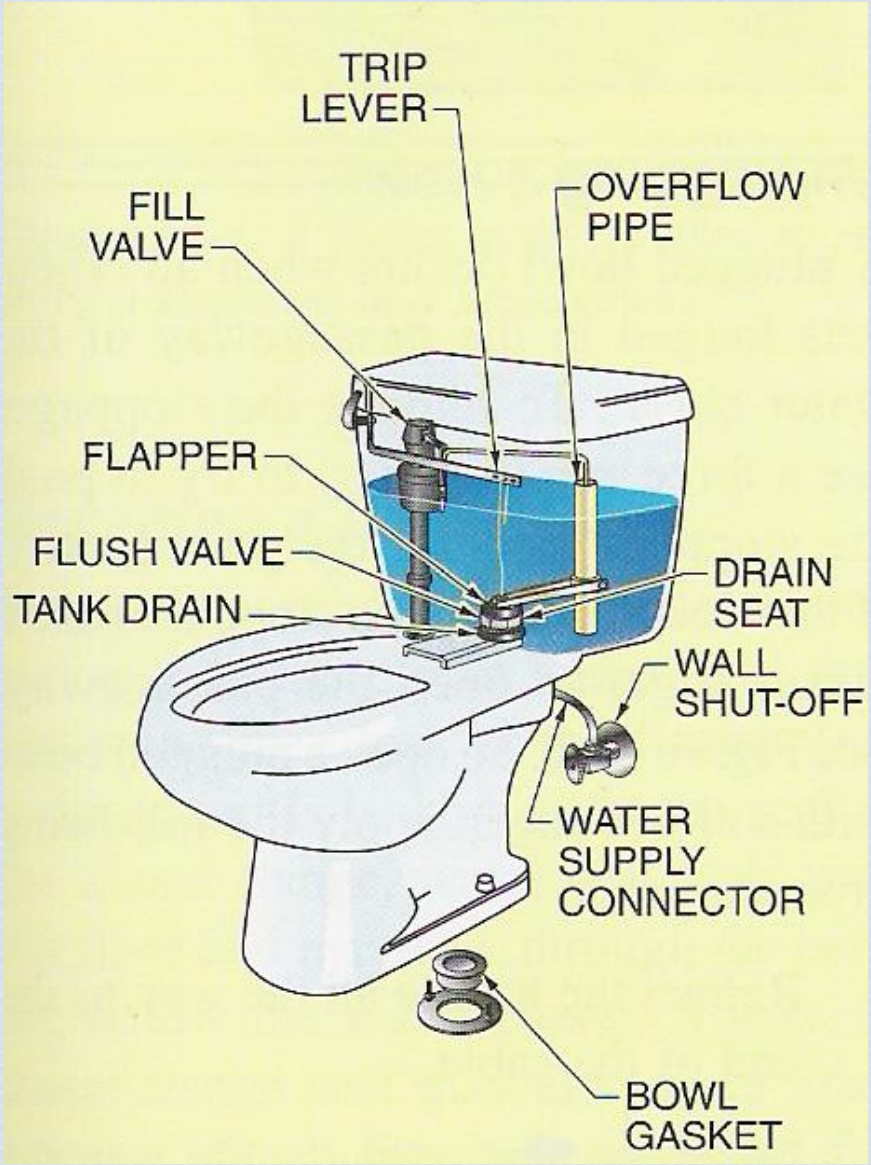
- Building / Plumbing services include:
  - Water distribution system
  - Sanitary fittings and
  - Effective drainage system

- Sufficient quantity of water is provided to the building for the needs such as drinking, bathing, washing of cloths and washing of floors. More quantity of water is used through sanitary fittings like water closets, washbasins, sinks, bath rooms etc..

- In addition, telephone services and electric fittings are also come under the preview of building services.

WATER DISTRIBUTION SYSTEM / WATER SUPPLY:

- Water supply to water closets, bath rooms, wash basins, kitchens etc of a building is provided through water supply pipes from municipal water mains which run along the streets.


TRIP LEVER
OVERFLOW PIPE
FILL VALVE
FLAPPER
FLUSH VALVE
TANK DRAIN
DRAIN SEAT
WALL SHUT-OFF
WATER SUPPLY CONNECTOR
BOWL GASKET


PEARIDGE CONCRETE

- Requirement of water for residences should be assumed as 135 liters per head per day whereas the requirement varies from 45 to 70 litres per day for schools / restaurants / offices per seat.
- For water supply to the buildings / offices, always galvanized iron pipe of 15 mm dia is used.

SANITARY LINES & FITTINGS

- For collection of water, various types of to be fitted in the building.
- All these fittings should be as far as possible be fitted against an external wall.

- Following are some of the examples for sanitary fittings:
  - wash basins
  - sinks
  - bath tubs
  - water closet

- **WASH BASINS:** These are used for face washing etc and usually fixed that top of the basin is 78.5 cm.

- **SINKS:** These are used cleaning of utensils in kitchens or glassware items in laboratories. Sinks are rectangular basins made from glazed earthen ware or stone-ware with flat bottom and all their internal angles are made round for easy cleaning.. Sinks are fixed in such a way that height of the top of the sink from floor is 90 cm.

- **BATH TUBS:** These are made from enameled iron, plastic, Cast Iron, porcelain, marble. Normal dimensions of bath tubs are as follows:
  - Length……1.7 - 1.85 mts
  - Width……..70 – 75 cms
  - Overall height …..58 – 60 cm

- **DRAINAGE SYSTEM:** Drainage of a locality can be divided into public drainage and private drainage systems.
- Under public drainage category, municipal sewers/drains are laid along the roads and are properly maintained by municipal / corporation authorities.

- Houses and buildings are constructed along both the sides of the roads by laying own sewer lines inside the house / building premises under the category of private drainage system.
- These sewer lines collect sewage / waste water from bathrooms, kitchens, water closets etc fitted in the building and convey it to the municipal sewers.

- The system of sewer lines or drains laid in the premises of a building is called the house drainage.

Principles of house drainage

- House sewers / drains should be laid as far as possible by the side of a building rather than below the building.
- The size of drain should be adequate for maximum discharge from the house.

- Drains should be laid at proper gradient so that the lowest level of the building may drain in it.
- Drain should be laid on good foundation and protected against external loads.
- As far as possible, drains should be laid in straight lines with successive inspection chambers.

- The house drain should be connected to the public

sewer line which is always lower than the level of house sewer else, the flow in reverse direction may take place.

VENTILATIONS

- The process of supplying fresh air and removing contaminated air by natural / mechanical process is termed as Ventilation.
- To provide excellent conditions to live and Work Air movement, temperature, Humidity conditions etc are important. The simultaneous control of temperature, humidity, air motion and air purity is known as air-conditioning.

SYSTEMS OF VENTILLATION

- A good ventilating system should fulfill the following requirements:
  - It should admit required amount of fresh air in the room.
  - All the corners of the room should get proper ventilation.
  - Desired humidity should be maintained.
  - Effective temperature should be maintained.
  - The ventilating air should be free from impurities such as dust, odour etc

- The systems of ventilation may be divided into two categories:
  - NATURAL VENTILATION
  - MECHANICAL VENTILATION

UNIT 4
MASONRY AND FORM WORK

Major Topics

- History
- Mortar
- Grout
- Brick
  - Types
  - Bond
  - Joints
- Structural Clay Tile
- Concrete Block (CMU)

Topics con't

- Masonry Panels
- Gypsum Block
- Glass Block
- Stone
- Stone Masonry

History

- One of the oldest manufactured building materials
- Sun-baked brick was found in the remains of structures in the Tigres-Euphrates basin as early as 6000 B.C.
- Romans also used thin bricks in thick mortar made of volcanic materials and lime.
- 1633 – 1st brick buildings erected in Manhattan Island (imported from Holland & England)

Masonry Defined

An assembly or combination of small building units made of clay, shale, concrete, glass, gypsum, or stone that are set in mortar.

Masonry consists entirely or partially of hollow or solid units laid contiguously in mortar.

Mortar

- Must conform to ASTM C270
- 4 basic types of mortar used: M, S, N, O
- Composed of: portland cement, hydrated lime, sand, and water
- Key to forming a strong and durable bond with masonry units

Mortar Types

Type	Avg Compressive Strength	Use
M	2500 psi	Masonry below grade and in contact with earth
S	1800 psi	Where maximum flexural strength is required (winds >80 mph)
N	750 psi	General use in exposed masonry above grade; parapets, chimneys, and ext. walls subjected to severe weathering
O	350 psi	Solid unit load-bearing walls Where compressive strength < 100 psi

Mortar Properties/Function:

- Have a tendency to shrink very little
- Have a high degree of resistance to moisture penetration
- Possess adequate strength to resist the forces applied to it
- Provide aesthetic qualities to the structure through the use of color and type of joint

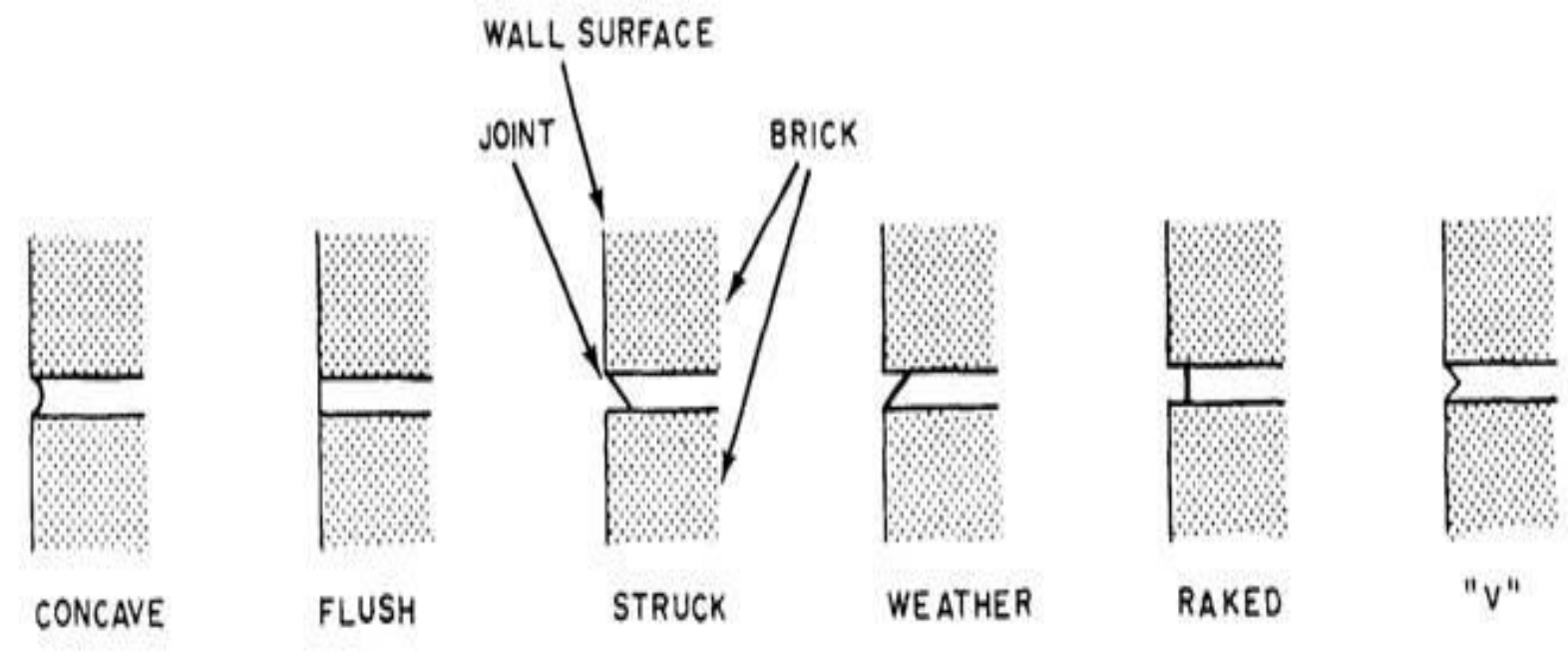
Mortar Basics:

- Brick masonry mortar made of portland cement, hydrated lime, and sand (stone masonry uses white portland cement [nonstaining].
- *Retempering – adding water to the mortar mix to maintain consistency*
- Mortar mix should be used within 2 – 2 ½ hours after initial mix is prepared
- *Efflorescence – the soft white powder appearing on the face of brick; caused by salts in the brick or mortar brought to the surface*

Mortar Joints:

- Joint sizes vary
  - Facing brick – 3/8” to ½”
  - Building brick – ½”
  - Glazed brick – 1/4 “
- Although many types of joints exist (see Fig. 4-3, pg 82), the most weatherproof & recommended are: *V-shaped, Weathered, & Concave*
- Joints may be formed by using a trowel, steel rod, or specialized tools

Types of Joints



Grout

- The water/cement ratio is less critical in grout than in mortar or concrete
- It is intended to be very “fluid” in order to function in it’s “binding” capacity (slump of 8-11 inches)
- May be used to fill cavities between masonry walls (often around vertical reinforcement)

Brick

- May be solid or hollow core (holes called “cells”)
- Cells should not exceed 25 % of the volume of the unit
- Bricks vary in size, color, shape, and texture.

Solid vs. With Holes

- Solid brick used where holes may be unsightly (steps or window sills)
- Holes in Brick:
  - Help units fire properly
  - Promote bonding with mortar
  - Reduce overall weight
  - Make units easier to handle

Classes of Brick

- Adobe – sun-dried clays and a binder
- Kiln-burned – natural sand and clay or shale (most widely used)
- Sand-lime – pearl-grey in color, dolomite lime is mixed with clean sand, pressed, and allowed to harden in closed vessels under steam pressure
- Concrete – portland cement and suitable aggregate, formed in molds

Brick Kilns

- Burning of brick is done in 4 stages
  - Water smoking: 400 °F
  - Dehydration: 300 -1800 °F
  - Oxidation: 1000 – 1800 °F
  - Vitrification: 1600 – 2400 °F
- Flashing (oxygen reduction)– produces different colors or color shading
- Cooling down – done in 2-3 days; rate of cooling will affect cracking, and color

Brick Types/Sizes

- Common (now called Building)
  - Most widely used
  - Dark orange to deep red color
  - Many finishes & sizes available
- Meets ASTM C62 grading criteria:
  - SW – severe weathering for exposure to heavy rainfall & freezing
  - MW – moderate weathering for avg. moisture and minor freezing
  - NW – Negligible weathering for exposure to moisture & freezing

Face Brick

- Made from clay, shale, fire clay, or a mixture, under controlled conditions
- Meets ASTM C216 standard
- Appearance types:
  - FBS- general use in exposed & interior walls where wide color ranges & variation in sizes are permitted
  - FBX- used in exterior & interior walls where a high degree of mechanical perfection, narrow color range & little variation of size is required
  - FBA- nonconformity in size, color, & texture

Glazed Face Brick

- Bricks sprayed with a ceramic glaze and fired at high temperature to fuse glaze to the brick
- Finishes may appear dull, satin, or glossy

Fire Brick

- Made of clays with a large amount of alumina, silica, flint, and feldspar
- These bricks are used in fireplaces, chimney stacks, incinerators, and many industrial settings

Paving Brick

- Bricks are burned at much higher temperatures to make them resist water and wear from traffic

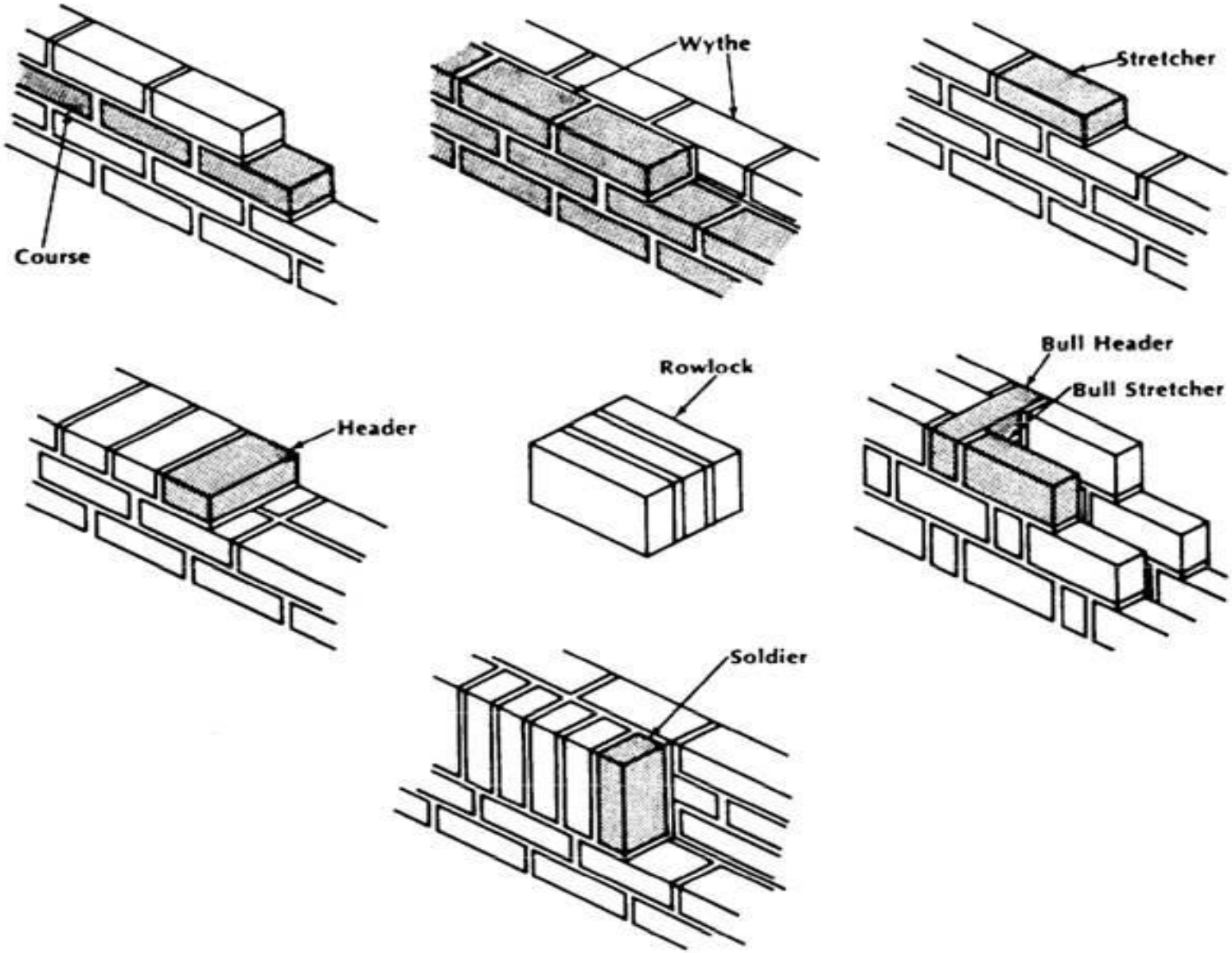
Nominal vs. Actual Size

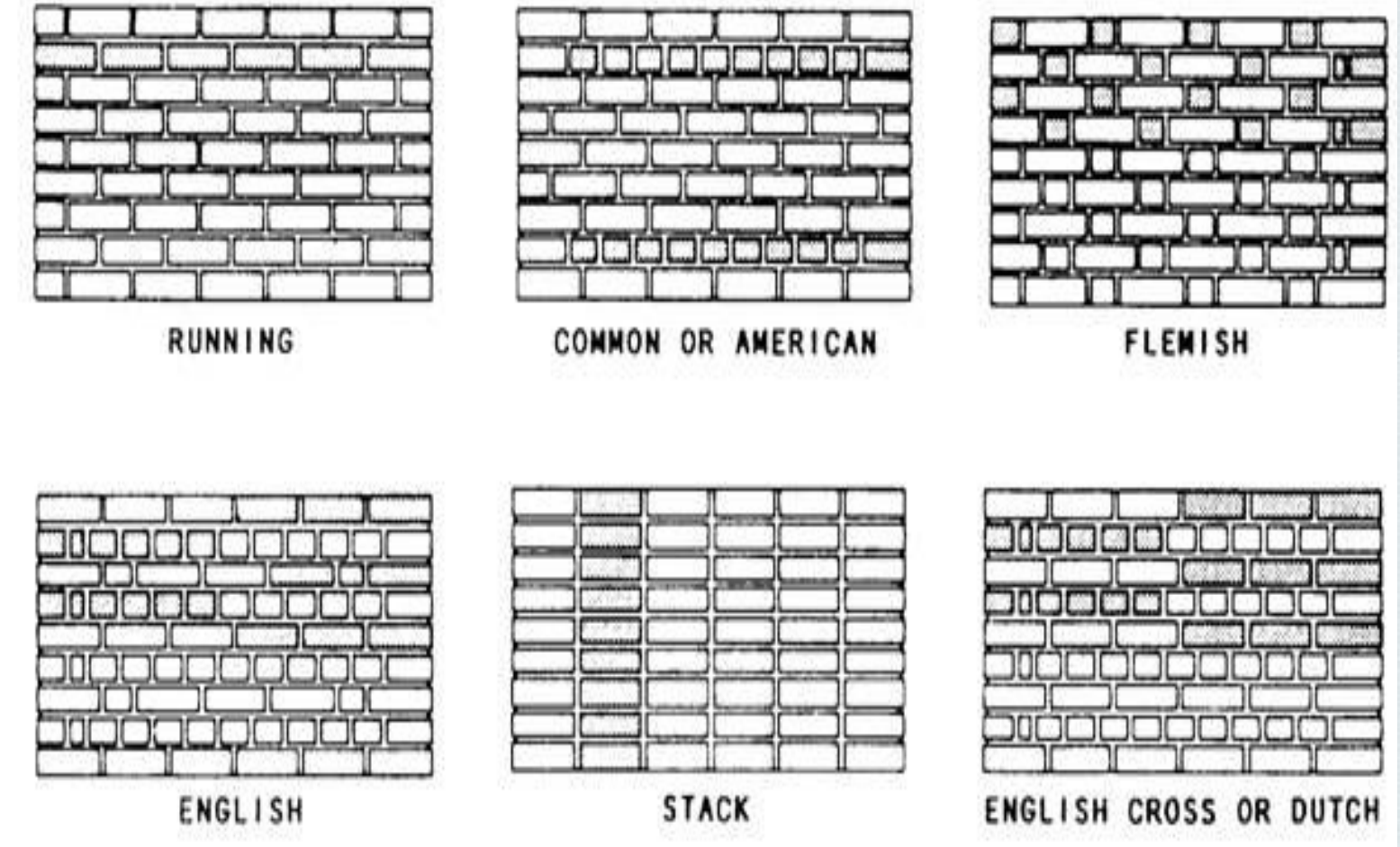
Unit	Nominal Dimension (in.) W x H x D	Actual Dimension (in.) ** W x H x D
Modular	4 x 2 2/3 x 8	3 5/8 x 2 ¼ x 7 5/8
Utility	4 x 4 x 12	3 5/8 x 3 5/8 x 11 5/8

** Note: actual dimensions may vary among manufacturers of brick – dimensions noted from *Graphics Standards* 2000 publication

Brick Bond:

- Bond – the arrangement of bricks in rows (courses).
- Bonds are designed for:
  - Appearance
  - To tie together a structural or outer wall (wythe) to an inner wall
- *Wythe – a vertical section of wall one brick thick*


Course
Wythe
Stretcher
Header
Rowlock
Bull Header
Bull Stretcher
Soldier


RUNNING
COMMON OR AMERICAN
FLEMISH
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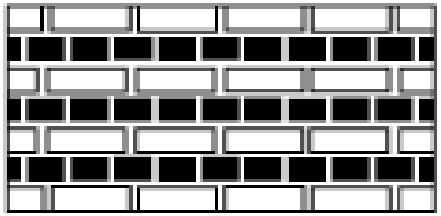
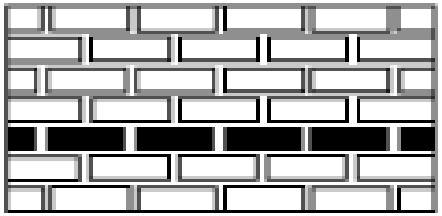
STACK
ENGLISH CROSS OR DUTCH

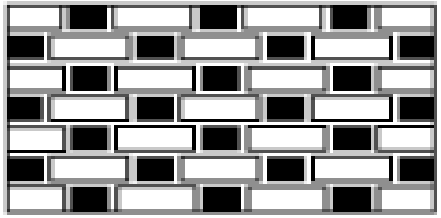


ENGLISH BOND

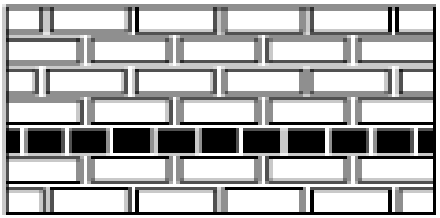


STRETCHER BOND

STRETCHER

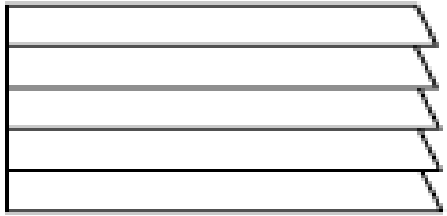


FLEMISH BOND

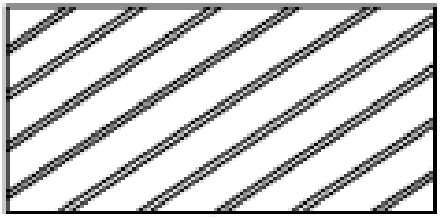


COMMON BOND

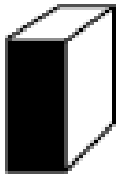
HEADER



CLAPBOARD
OR WEATHERBOARD



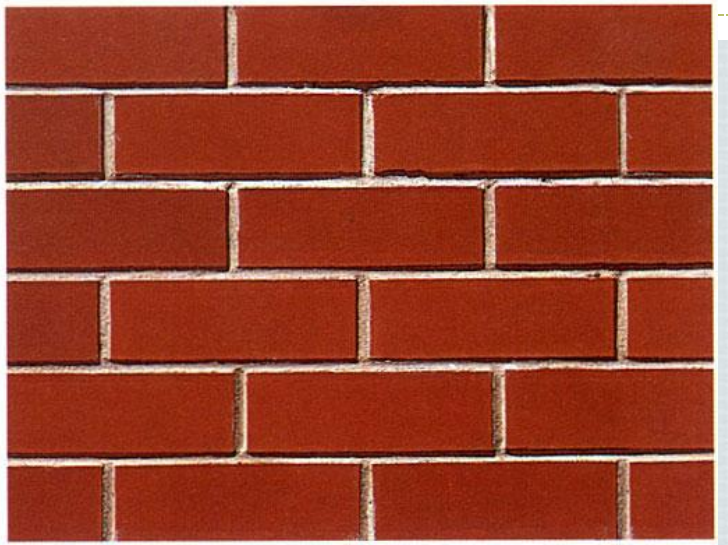
DIAGONAL SIDING



SOLDIER

Examples of Brick

FLAME RED



IVORY SANDSTOCK with cream mortar

Brick Walls

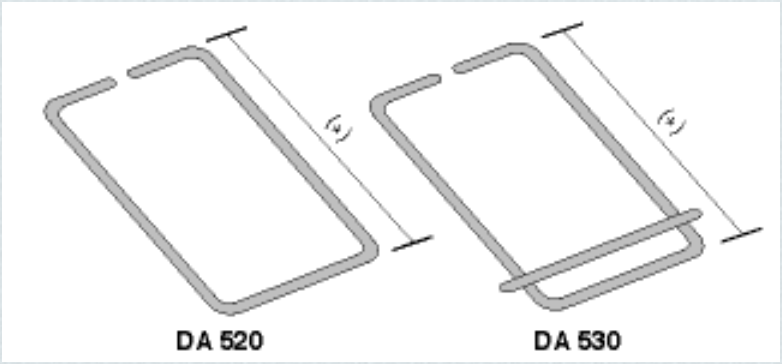
- May be bearing (supports any vertical load) or non-bearing
  - Solid walls- 2 or more wythes bonded together by ties, headers
  - Cavity walls – 2 walls spaced 2 in. apart by metal ties; may fill cavity with insulating material; *Weep holes must be in outer wall in order for moisture to escape* ; not allowed in earthquake zones

Brick Walls con't

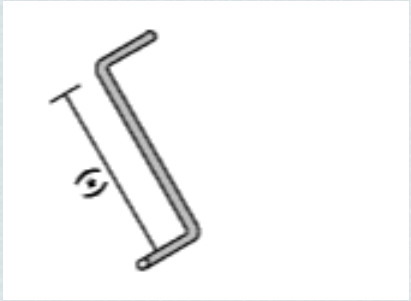
- Faced walls – brick masonry units bonded to a backup wall of another material (common brick, hollow structural clay tile, or CMU)
- Veneered walls – facing material is securely tied to a structural wall but NOT bonded to it (common residential wood-frame construction)
- Reinforced brick masonry – steel reinforcement is placed vertically & horizontally and often grout surrounds it (spacing governed by local code requirements)

Ties

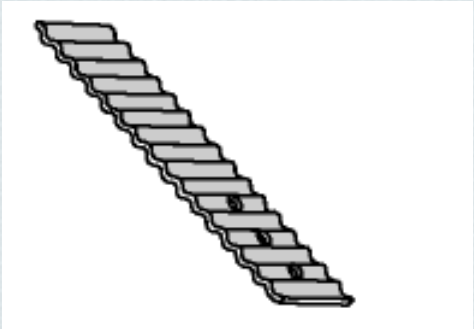
- May be standard unit ties or adjustable
- Number and placement of ties depends on application and building code requirements



"Adjustable Box Anchor" – designed to tie multi-wythe walls



"Z" tie – multi- wythe walls when fully grouted

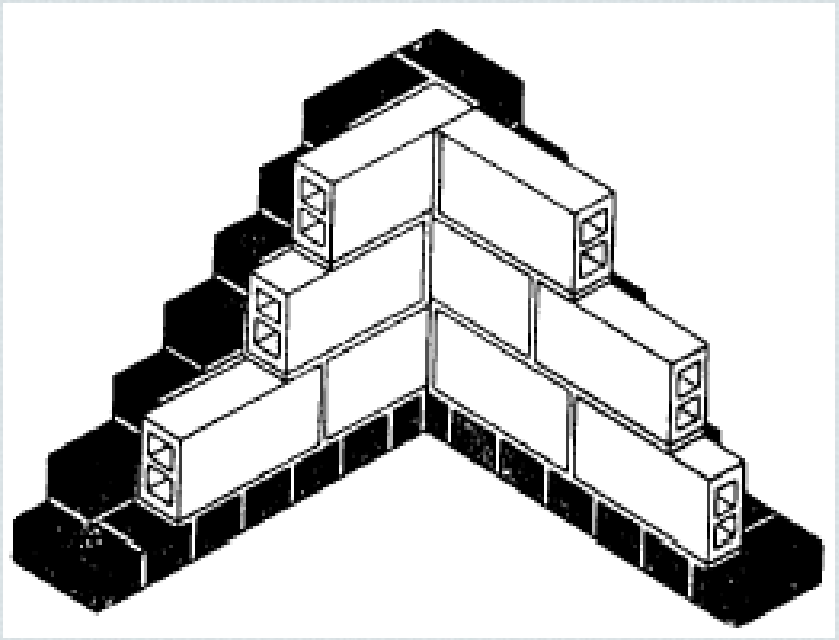


"Corrugated" wall tie – veneer walls

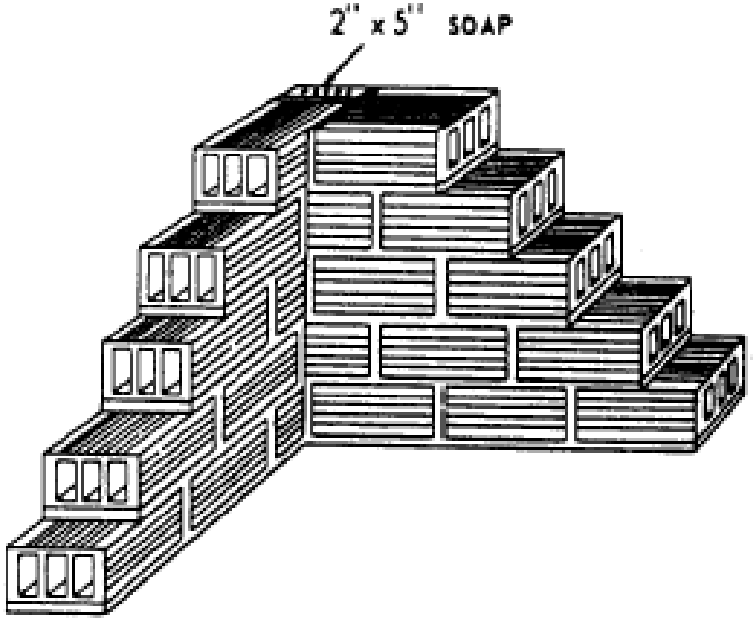
Structural Clay Tile

- Burned-clay units, larger than bricks, with vertical or horizontal cells
- May be smooth, rough or scored faced
- May be non-load or load bearing
- Terra Cotta, ocher to red in color, is used as an non-load bearing ornamental material

Structural Clay Tiles



Clay tiles used as a backing for brick wall

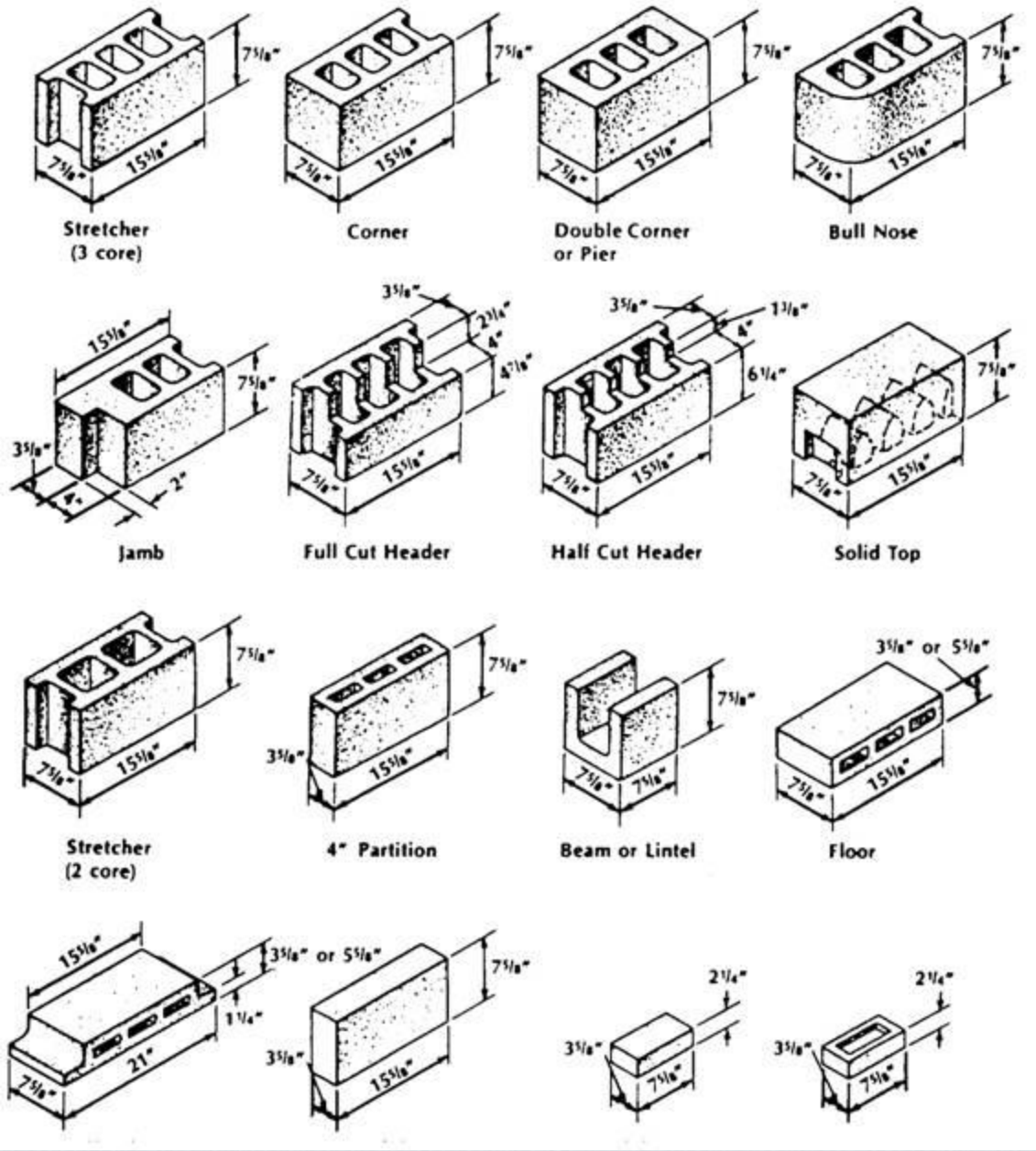


8” clay tile wall

Concrete Masonry Unit (CMU)

- Hollow (or solid) masonry units used for interior/exterior bearing or non-bearing walls, partitions, and backing.
- The aggregate used to make the units will determine the weight (25-50 lb. for 8” x 8” x16” stretcher unit)
- Nominal sizes include: widths- 4”,6”,8”,10”,12”; lengths- 6”,8”,12”, 16”, 24”
- Have good fire-rating, thermal storage capability, good resistance to sound transmission, and are economical.

CMU Types


Stretcher
(3 core)
Corner
Double Corner
or Pier
Bull Nose
Jamb
Full Cut Header
Half Cut Header
Solid Top
Stretcher
(2 core)
4" Partition
Beam or Lintel
Floor

CMU Screen Units

- Used to form a wall (screen) for privacy (walls in carports), separation of spaces, and architectural details (cast shadows).
- Sizes and geometric shapes (patterns) are varied. Sizes may include 4” –12” squares.

Surface Bonding (BlockBond)

- CMU is laid dry with vertical steel grouted in place.
- 2 coats of BlockBond is sprayed on inside and outside of walls
- Surface may be textured and requires no paint
- Colors include white, beige, and gray

Gypsum Block

- Lightweight, used in non-load bearing applications, fire-resistant, interior locations
- Concern: never use in areas in which moisture exposure could occur

Glass Block

- Often used for their decorative effect but also:
  - Provide controlled light transmission
  - Good insulation
  - Condensation protection
  - Good sound reduction

Glass Block con't

- The blocks are formed of 2 cast glass shells that are fused together to form a hollow unit containing a partial vacuum. The vacuum decreases heat transmission and surface condensation.
- Faces can be:
  - Smooth – provides vision through the block
  - Textured – provide only light transmission
  - Opaque – fired with a ceramic finish

Glass Block con't

- Common sizes are 6", 8", 12" sq. by 4 " thick
- Mortar joints typically ¼ "
- Usually laid in a stack bond (can only support their own weight)
- Concern: glass block expands 1.5 to 2 times more than a brick wall & therefore, must have expansion joints

Stone Classification

- Igneous – formed by the solidification of molten rock such as volcanic activity (Granite)
- Sedimentary – formed from silt, marine life, and rocks that have been deposited by running water (Limestone, Sandstone, & Travertine)
- Metamorphic – igneous or sedimentary rock that have been changed by pressure, heat, or moisture (Marble, Slate)

Stone- General Information

- The removal method (quarrying), sizes, shapes (smooth round, angular), thickness, textures, finish, and application & installation vary for each type.
- There are natural stones as well as cultured (man-made) stones used in building materials.

Stones & Uses

Stone	Color	Major Use	Minor Use
Granite	Wide Range	Ext. & Int. wall facing	Paving, Flooring
Limestone	Buff, Gray	Exterior wall facing	Copings, Sills, Interior wall facing
Marble	Wide Range	Ext. & Int. wall facing, flooring	Countertops
Sandstone	Yellow, Brown, Reds, Tan	Exterior wall facing	Paving
Slate	Blue, Gray, Green, Red, Black	Paving, Roof Shingles	Wall facing
Travertine	Tan, Buff, Gray	Ext. & Int. wall facing	Flooring, Paving

Examples of Stone

Stone Masonry

- Walls classified in 3 categories (based on shape & surface finish)
  - Rubble – stones as they are collected (fieldstone) or as they come from quarry
  - Ashlar – constructed of squared stones set in random or uniform courses
  - Cut stone (dimension)- fabricated and finished at the mill ready to set in place per the specifications

Fieldstone (rubble)

Ashlar (squared)

Masonry Restoration

- 4 causes of deterioration
  - Freeze/Thaw Cycle – causes fractures
  - Wet/Dry Cycle – capillary action produces force that is stronger than the masonry
  - Thermal Expansion/Contraction – entire structure expands/contracts with change in temperature
  - Salt Crystallization – if on surface of masonry will cause efflorescence; if under surface may lead to crumbling

Masonry Cleaning

- Water Mist – will remove surface deposits; problem is entrapment of moisture
- Chemical – may damage masonry if not suitable for that particular type
- Muratic Acid Solution – may etch surface, change color of masonry
- Abrasive – (sandblasting & pressure washing) may damage surface; remove mortar

UNIT 5
Building Planning

Why Plan?

- A plan helps you focus on the goal
  - "Begin with the end in mind.[1]"
- A plan let's you estimate job completion
- A plan helps you track progress
- A plan gives you milestones that provide a sense of accomplishment along the way
- A plan helps you identify problems early
- A plan establishes commitments for the team and each individual on it

[1] Stephen R. Covey, *The Seven Habits of Highly Effective People*

The Planning Process… Simplified

- **Plan** the work

  … then **work** the plan
- **Refine**, refine, refine…

What is a Plan?

- An agreement by the team on the cost and schedule for a specified job
- A structure for organizing the work
- A framework for obtaining the required resources (people, funds, etc.)
- A record of what was initially assumed and committed
- It's a CONTRACT!

Components of a Plan

- A Lifecycle Planning Model: The Master Plan for the Project
  - Order and criteria for key events
  - Correct model for the job?
- Work Estimate
  - How big is the job (size and effort)?
  - How long will it take, when will we finish?
- Schedule and Work Breakdown
  - When do we expect to have things done?
  - What are we committing to?

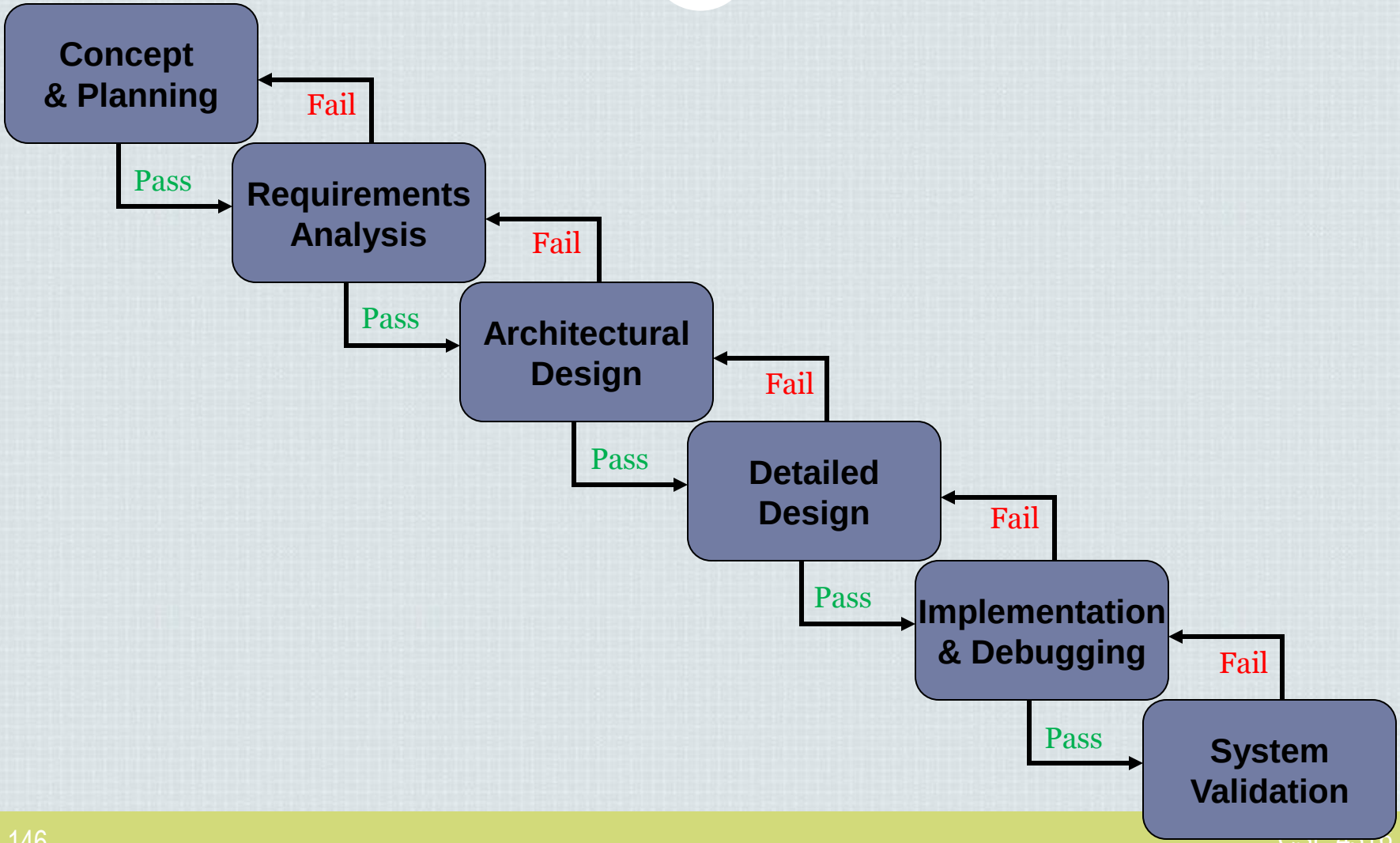
Representative Lifecycle Models

- Pure Waterfall (the old granddaddy)
- Code-and-Fix (and plan to fail)
- Spiral (new age sophistication)
- Modified Waterfalls (making the best of an old standby)
- Evolutionary/Rapid Prototyping (design as you go)
- Staged Models (show as you go)
  - Design to schedule
- Hybrids – some combination of above

Pure Waterfall

- Phased deliverables
- *Document-driven*
- Discontinuous, inflexible phases
- All planning is done up front
- Good for:
  - Well-defined, complex projects
  - Quality dominates cost and schedule
- Not so good for:
  - Projects where details cannot be completely specified up front
  - Rapid development projects

Pure Waterfall



Build (Code)-and-Fix

- In general, don't do it!
- Process: Specify it, code-and-fix it, ship it(?)
- Advantages:
  - Low/no overhead (no planning, documentation, standards, etc.)
  - You can start TODAY!
  - Requires little other than technical expertise
- Disadvantages:
  - No means of assessing progress, problems
  - Dangerous! for other than tiny projects

Spiral

- Risk-oriented, layered approach
- Process:
  - Break project into mini-projects, each addressing major risks, e.g.
    - Risk of poor specifications
    - Risk of poorly understood architecture
  - Iterate until risks are eliminated
    - Six steps in each iteration
- Advantages:
  - Time and money can reduce risk
- Disadvantages
  - Complex

Spiral

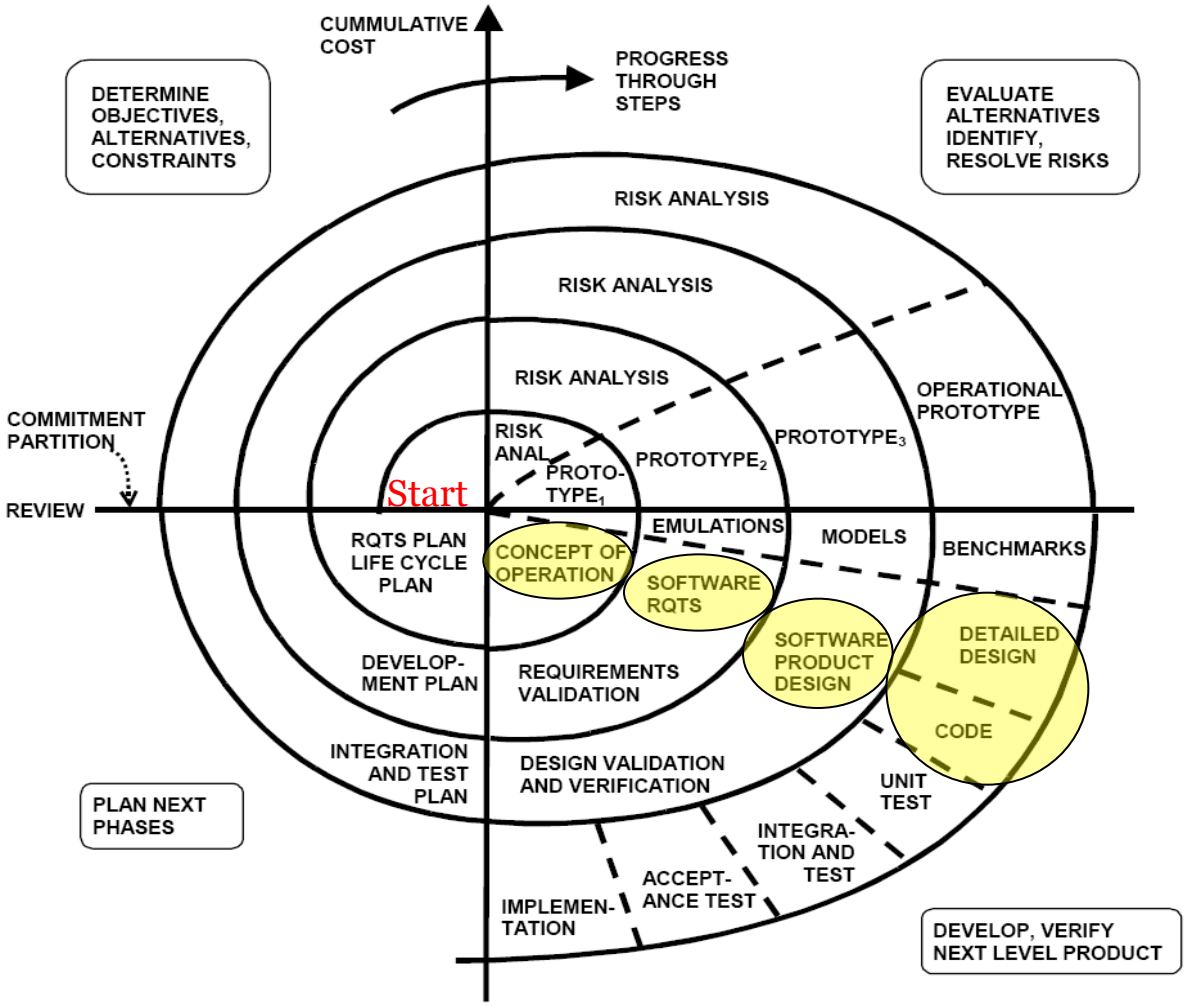
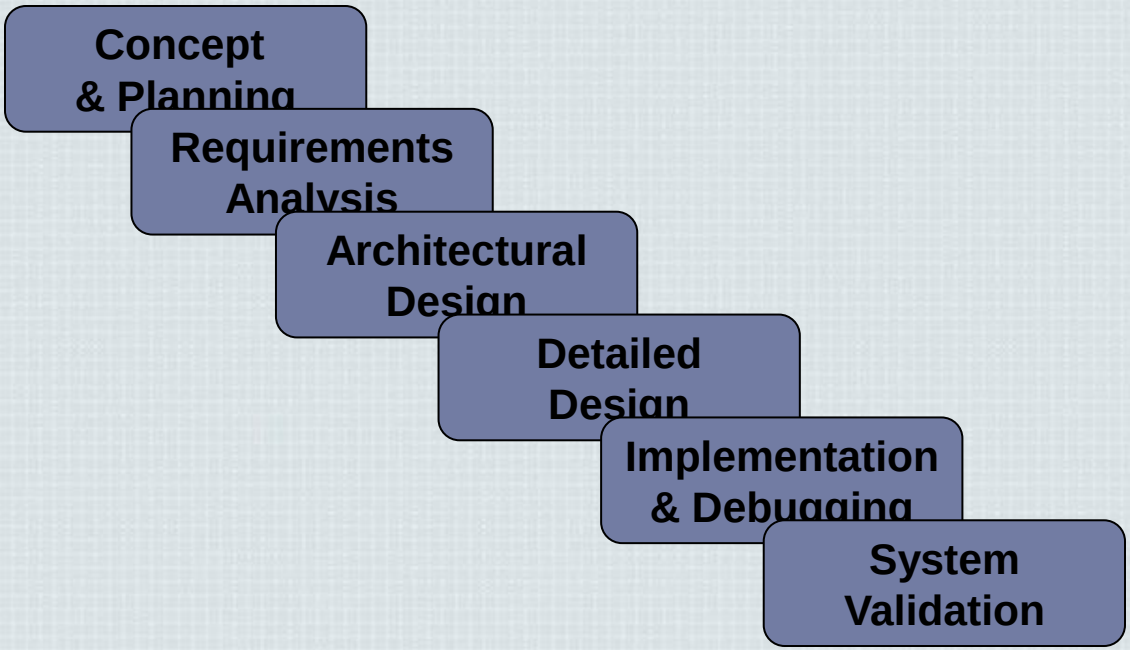


Figure 1: Original Diagram of Spiral Development

(Diagram from "*Spiral Development: Experience, Principles and Refinements*", workshop paper by Barry Boehm)

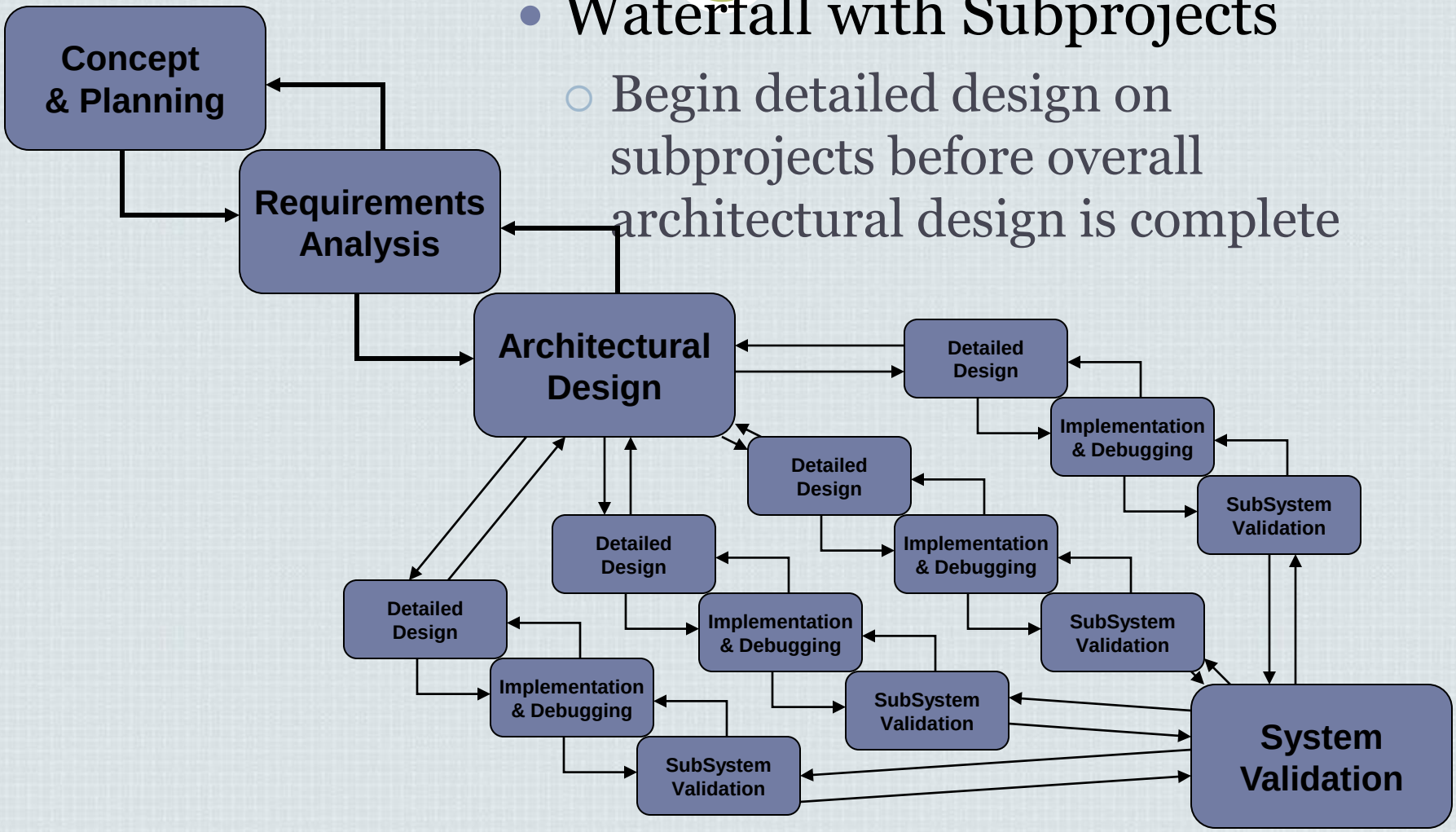
Modified Waterfalls

- Waterfall with Overlapping Phases (Sashimi)
  - Like pure waterfall, but phases can overlap



Modified Waterfalls

- Waterfall with Subprojects
  - Begin detailed design on subprojects before overall architectural design is complete



Modified Waterfalls

- Waterfall with Risk Reduction
  - Spiral for requirements and architectural design phases

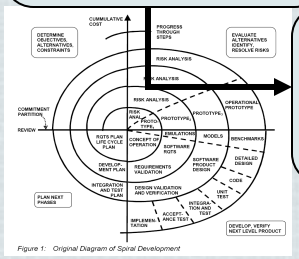


Figure 1: Original Diagram of Spiral Development

Concept & Planning

Requirements Analysis

Architectural Design

Detailed Design

Implementation & Debugging

System Validation

- Generally, only for very large and complex projects

Evolutionary (or Rapid) Prototyping

- Especially useful when requirements are changing rapidly, or cannot be committed
- Process:
  - Design initial prototype of external/prominent aspects
  - Review with customer
  - Iterate and refine until "good enough"
- Advantages
  - Keeps customer involved in process
  - Low overhead
- Disadvantages
  - Impossible to project schedule/budget
  - Can evolve to code-and-fix

Staged Delivery Models

- Follow architectural design with staged design, implementation, test and delivery
  - Staged delivery: iterate until done
  - Design-to-schedule: iterate until scheduled time
  - Evolutionary delivery: Iterate with customer feedback until done (Beta test approach)

Agile Methodologies

- Iterative and incremental development
- Adaptive planning based on customer and market changes
- Plan milestones are flexible and subject to change
  - "rolling wave" progression
  - TimeBox development
  - Staged (potentially shippable increments)
  - Scrum

Hybrid Staged Delivery Model

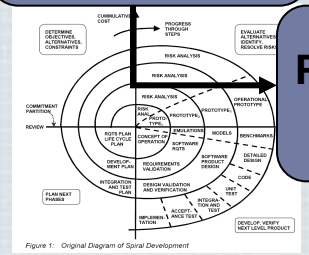


Figure 1: Original Diagram of Spiral Development

Concept & Planning

Requirements Analysis

Architectural Design

Design-to-Schedule with risk reduction (our model, approx.)

High Priority: Detailed design, implement and test

Medium High Priority: Detailed design, implement and test

Medium Priority: Detailed design, implement and test

Medium Low Priority: Detailed design, implement and test

Low Priority: Detailed design, implement and test

Release

Run out of time and money

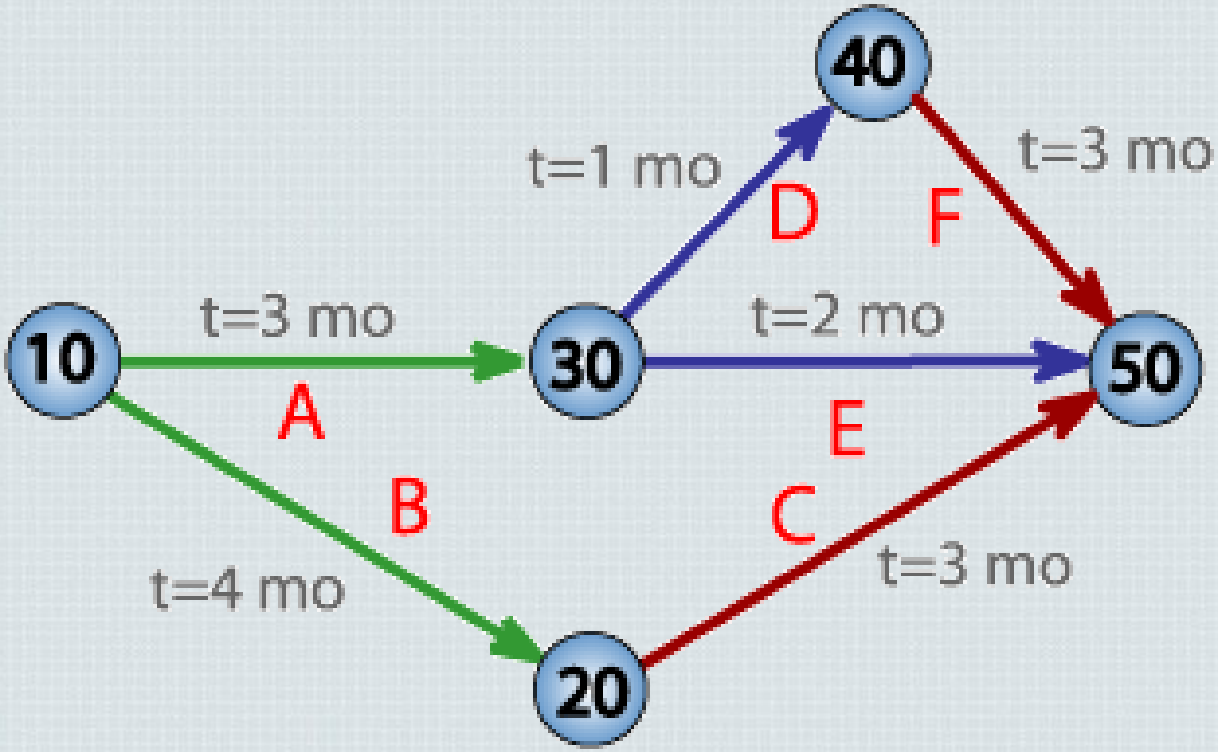
Choosing the Right Model

- Strengths and weaknesses analysis
  - Discussion: Table 7-1
- Case Study 7-2: Effective Lifecycle Model Selection
  - Project characteristics
  - Why was the model the right one?
  - What was the outcome?

Tools/Techniques to Help You

- PERT and CPM Tools
  - Program (or Project) Evaluation and Review Technique
  - Critical Path Method (from Dupont)
  - Account for task dependencies
  - Generally applies 3 separate estimates for each task (shortest, nominal and longest) to calculate the expected effort
    - Identify longest/critical path(s)

Tools/Techniques to Help You (PERT Chart)



Tools/Techniques to Help You

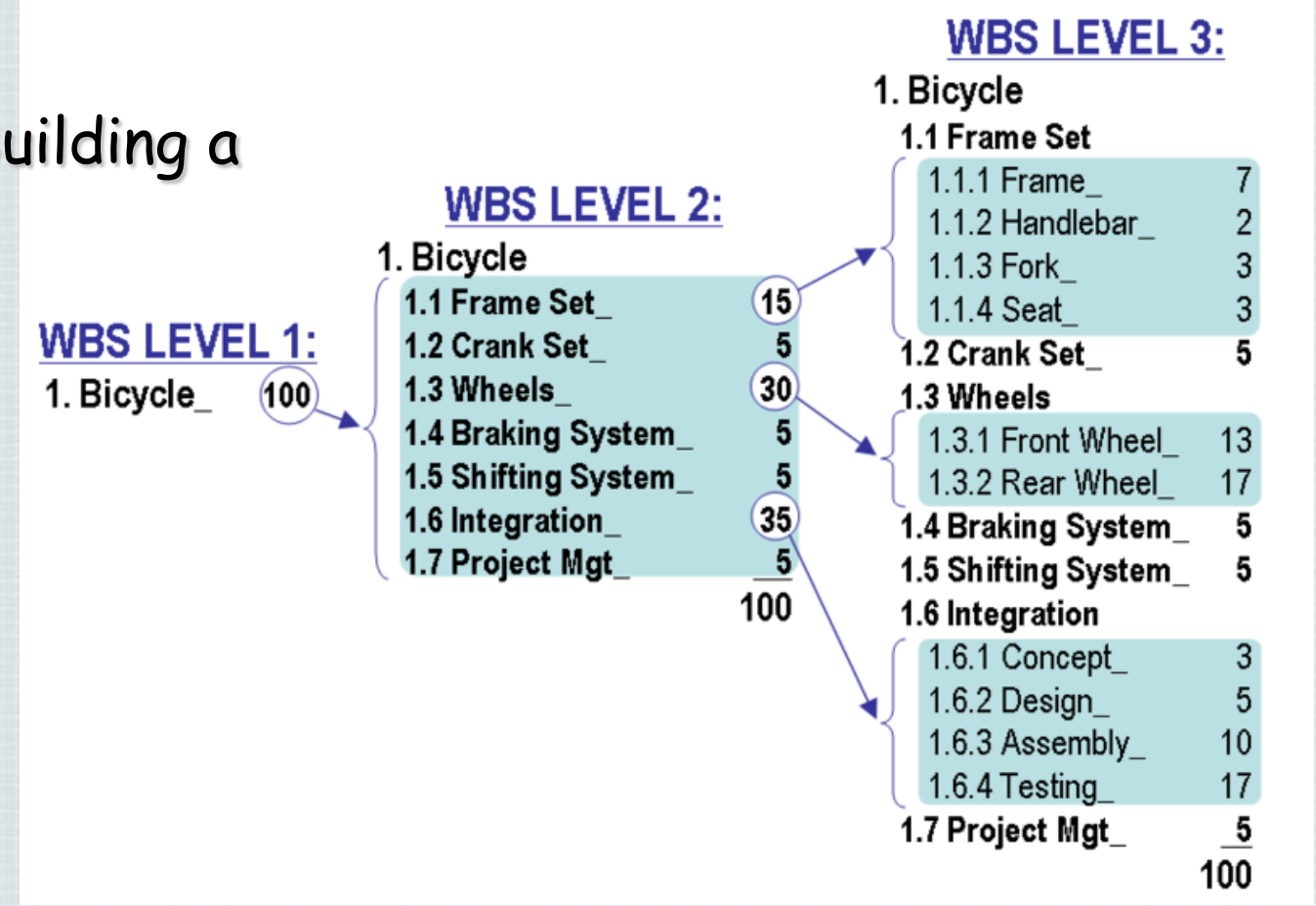
- CoCoMo (Constructive Cost Model)
  - Estimating tool created by Barry Boehm (*Software Engineering Economics, 1981*)
  - Based on size, complexity, environment, team composition, language, tools, etc.
  - Method is based on a large study of varying size significant projects.

Work Breakdown Structure

- Breaks down the work to be done into specific, product-oriented manageable units
- Allows development of a detailed plan
  - Basis for project cost and schedule
- Enables assignment of responsibility
  - Provides basis for accountability of individuals
- Defines independent work units – minimum interfacing with or dependency on other work units
- Allows measurement of progress

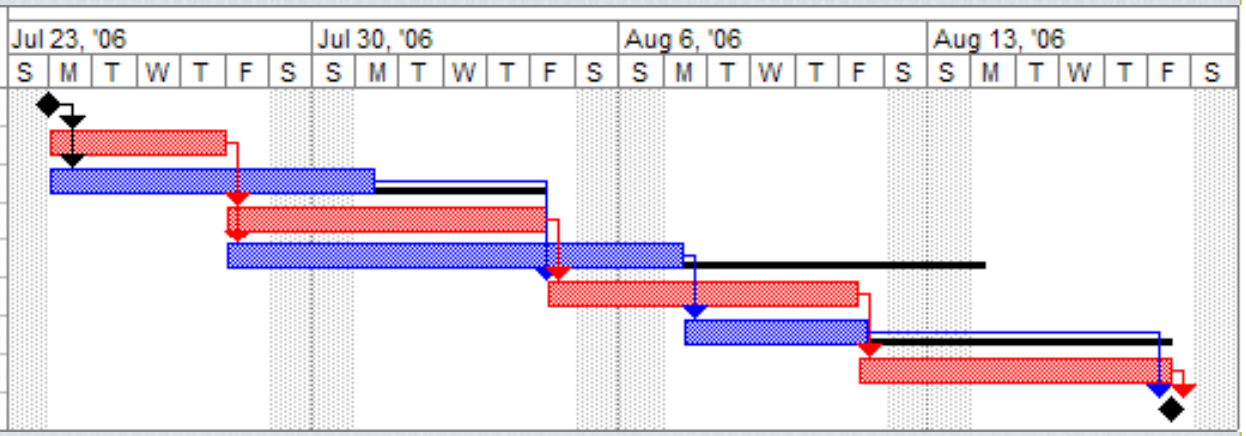
Work Breakdown Structure

WBS: Building a Bicycle



Milestone Tracking - GANTT

ID	Task Name	Predecessors	Duration
1	Start		0 days
2	a	1	4 days
3	b	1	5.33 days
4	c	2	5.17 days
5	d	2	6.33 days
6	e	3,4	5.17 days
7	f	5	4.5 days
8	g	6	5.17 days
9	Finish	7,8	0 days



GANTT Chart Display Using MS Project

See Sample MS Project file on website.

High Quality Plans

- Characteristics, as stated in the SEI text
  - Complete
  - Readily accessible, even by the customer
  - Clear
  - Specific
  - Precise
  - Accurate
- Not in the SEI text, but necessary
  - MEASURABLE

What's makes a Good Plan?

- Complete Product Specifications — SRS…ADS/DDS
- A clear Statement of Work
  - Size estimate and schedule — PROJECT CHARTER
- Schedule for critical Milestones
- A complete Work Breakdown Structure — MS PROJECT PLAN
- The Processes/Procedures that you will follow
- Identification of your Stakeholders — PROJECT CHARTER

What's makes a Good Plan?

- From the customer's perspective:
  - Your commitment to deliver what is specified
  - The quality level of the product
  - A mechanism for participation/cooperation

Integrity and Openness

Product Specifications

- Provide the details of *what* will be done, and *how* it will be done:
  - Requirements Specification (SRS – *what*)
  - Architecture Design (ADS – *bridge* what to how)
  - Detailed Design Documentation (DDS - ***how***)
- These provide the basis for system verification and acceptance

Statement of Work

- A narrative description of the work that is to be done:
  - Details of hardware and software components
  - Description of deliverables
  - Estimate of start and stop dates for key phases of process
  - Acceptance criteria

Milestones

- Driven by the lifecycle model you use
  - Establishes start and stop dates for all key phases of project
  - Reinforced by your detailed schedules
  - Use PERT/GANTT
- Provides basis for measurement of progress
  - Earned Value
- Provides basis for identifying and estimating risks
- Specifies critical deliverables
  - ALL milestones have deliverables!

Processes/Procedures

- Defines *how* things will get done
  - Provides the basis for establishing critical milestones and deliverables
  - Establishes entry and exit criteria for critical phases
  - Establishes the standards that will be used
  - Defines the tools that are required to complete the work

Stakeholders

- Any person or organization that has a vested interest in the success of you project
  - Your customer or sponsor
  - Your company
  - Your company's owners/stockholders
  - Your management

Plan Documentation and Tracking

- System Requirements Specification
  - WHAT you plan to create
- Project Charter
  - HOW you will go about the process of creating the WHAT
  - Includes RISK MANAGEMENT plan
- Work Breakdown Structure/GANTT
  - The specific STEPS you will take, WHEN things must be done, and WHO will do them
  - MS Project

Characteristics of a Good Requirement

- Verifiable: stated in a way that allows for independent verification that the system meets or exceeds the stated requirement.
- Justifiable: necessary, rather than simply desirable
- Unambiguous: stated such that multiple interpretations are precluded

Characteristics of a Good Requirement

- **Consistent**: no conflict with any other requirement
- **Modifiable**: should be stated in a way that allows for change based on technical/business considerations.
- **Hierarchically Traceable**: should define a single attribute, traceable back to a higher level requirement.

Tips for Successful Requirement Determination

- Start by establishing what the team thinks the features/functions of the system should be
  - Brainstorm as team and write everything down
  - Keep a simple list (such as the requirements worksheet on the website)
- Meet with your sponsor to review/modify your list and discuss alternatives
  - Add any features/functions that the sponsor believes are required

Tips for Successful Requirement Determination

- Consider and add ancillary requirements
  - E.g., performance, packaging, look and feel
- Discuss and add as necessary any "non-functional" requirements
  - E.g., standards that you must adhere to, maintenance and support, safety
- Discuss and analyze the feasibility of meeting or exceeding each requirement within the budget, time and skills allowed.

Tips for Successful Requirement Determination

DO NOT collect requirements by attempting to fill out the SRS Guide!

- List and understand them, THEN write the document

What is a System Requirements Specification (SRS)?

- A detailed description of the features and functions of a product, incorporating:
  - End-user and sponsor input
  - Developer input
  - Management input
  - Standards and processes
- Your documented commitment to deliver
- Your contract with your stakeholders that identifies WHAT you will create

(See SRSs from prior teams on class website.)

What is a Project Charter?

- A document that summarizes the project
  - Defines the scope and objectives of the project
  - Delineates organizational relationships
  - Delineates individual authority and responsibility
  - Identifies key risks and plan to handle them
  - Specifies dependencies on other organizations
  - Describes the specific functions to be performed
  - Lays out the master schedule for the project
  - Documents cost and time estimates
  - Document person-loading requirements/schedule
  - Documents management approval of the details of the project

(See Charter template and Charters from prior teams on class website.)

Thank you