

02

PREPARATION FOR CONSTRUCTION

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PREPARATION FOR CONSTRUCTION

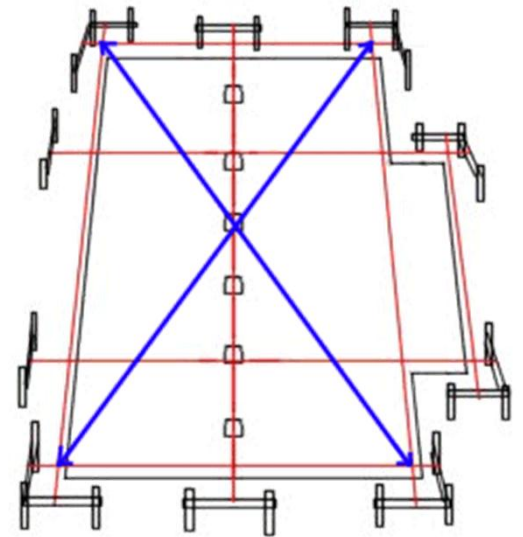
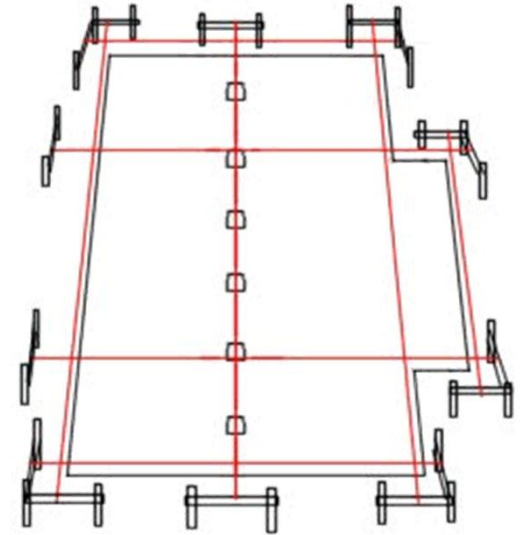
STAKING-OUT THE BUILDING

Before staking-out, it is advisable to go through the process of relocating the point of boundaries and property line of the site where the building is to be constructed. **Staking-out is the driving of stakes for batter boards to locate the corners and foundations of a building for excavation.**

1. Measure the required setback from the front corner monuments. Drive two stakes and stretch a string between them to represent the front building line.
2. Measure the required side setback from one of the side lot lines along the front building line. Drive stake A which will represent the first corner of the building. From Stake A, measure the width of the building and mark with stake B to obtain the other front corner.
3. Estimate right angles from stakes A and B and measure the length of the building. In those two points, drive two temporary stakes C and D which will mark the rear corners of the building. C-D should be equal to A-B.
4. Draw lines along the diagonals A-D and B-C and ensure that these are equal.
5. Transfer the building lines to batter boards.

Stakes – are wooden sticks used as posts sharpened at one end driven into the ground to serve as boundaries or supports of the batter boards.

Strings – are either plastic cords or galvanized wires strung across batter boards and used to indicate the outline of the building wall and foundation.



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Construction Tools &

Equipment

Major Parts of a Building

Foundation Bed

Site Investigation

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Excavation & Earthworking

Site Drainage

Slope Protection and

Retaining Structures

Pavements

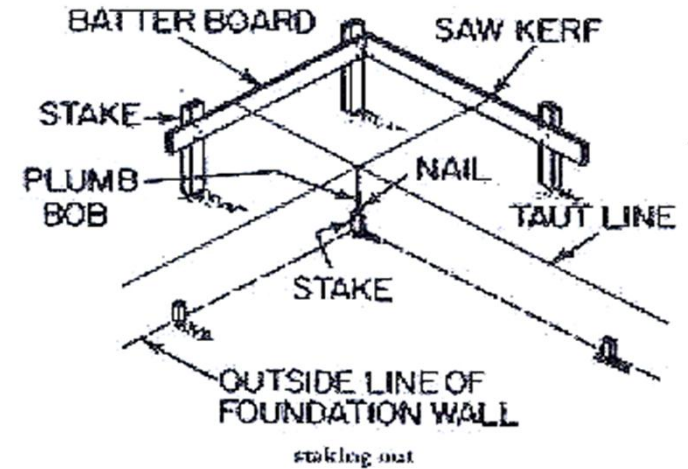
LAYING THE BATTERBOARDS

BATTER BOARDS

- horizontal boards
- establishes height of the footing trenches and foundations
- establishes height of finish floor levels

LEVELING

- done with a line level or carpenter's level, or with a transit
- height of the batter boards may be level with or a little higher than the top of the finished foundation.



Batter Boards – wood sticks or boards nailed horizontally at the stake which serve as the horizontal plane where the reference point of the building measurements are established.



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Notes:

Spirit Level – an instrument or tool capable of vertical and horizontal line check.

Plumb Bob – a weight attached to a string, used for vertical line check.

Plastic Hose Filled With Water – a method of leveling horizontally batter boards without transit.

3-4-5 Multiples With the Use of Steel Tape Measure – a manual method of squaring the corners of building lines in staking.



PLUMB BOB

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FORMWORK AND SHORING

Formwork - used to shape and support fresh concrete until cured and able to support itself.

Shoring - temporary supports designed to carry forms for beams and slabs.

FORMS FOR CONCRETE CONSTRUCTION.

Materials used for form construction are:

- 1. LUMBER FORMS**
 - should only be partially seasoned.
- 2. PLYWOOD FORMS.**
 - used where a smooth surface is required
 - should be waterproof, Grade "A" and at least 1/2" thick.
- 3. STEEL FORMS**
 - may be in the form of pans for concrete joist construction or steel decking or corrugated steel for concrete slabs and slab-and-joist construction.
- 4. FIBER BOARDS**
- 5. PHENOLIC BOARDS**

Phenolic resin or phenol-formaldehyde resin –

is a thermosetting, waterproof, low-cost, mold-resistant, high strength synthetic resin made from phenol and formaldehyde; has good resistance to aging; used extensively in the manufacture of adhesives, exterior and marine plywood, laminated products, and molded articles.



TWO MAJOR MATERIALS USED FOR FORMS AND SHORING CONSTRUCTION ARE:

(1) LUMBER

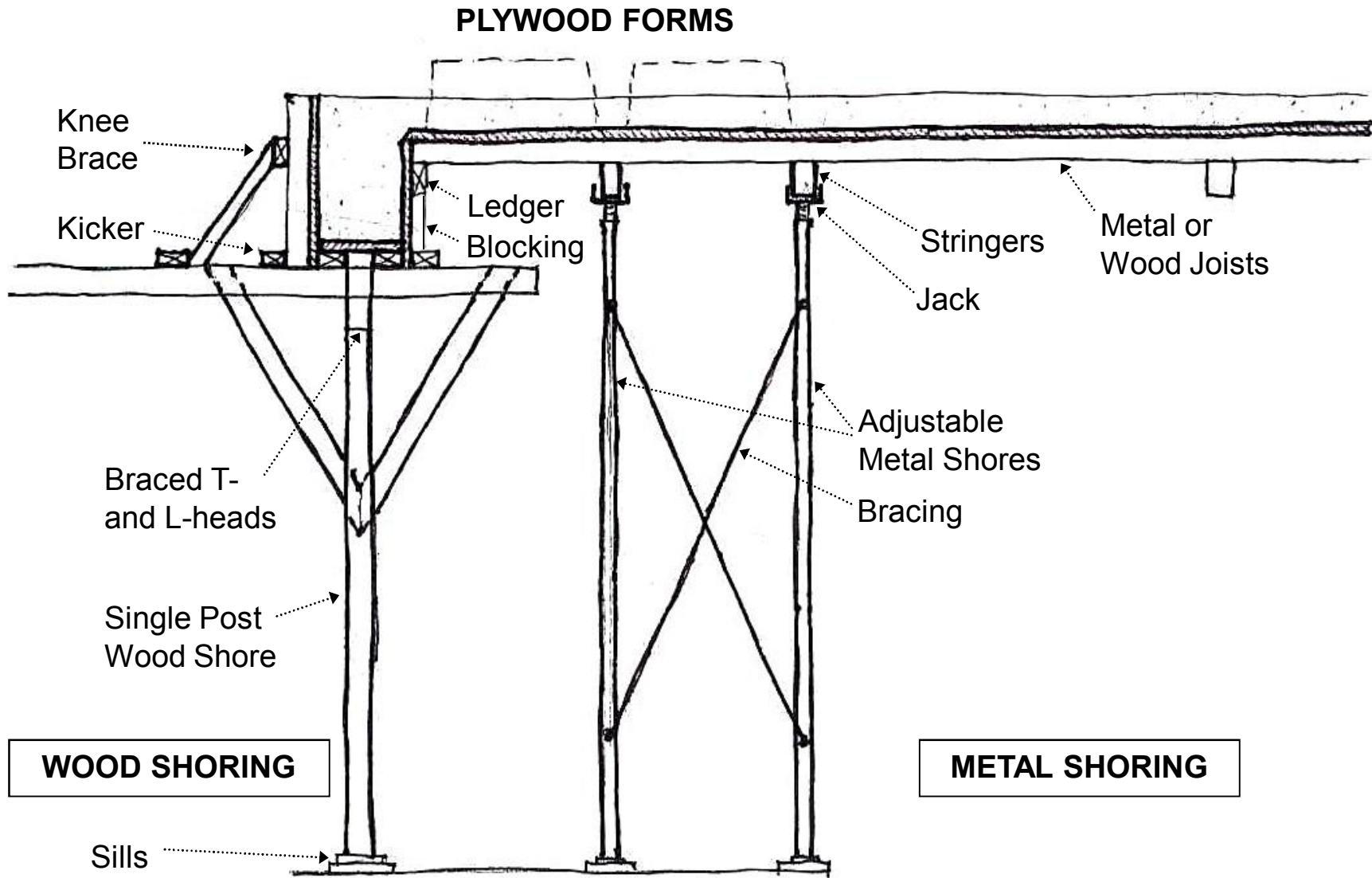
(2) STEEL.

1.3.1 Lumber Forms and Shoring

- partially seasoned and to some extent **slightly wet** in order to prevent swelling and distortion of the forms;
- **dressed at least one side** and both edges even for non-exposed surfaces;
- joints in forms for columns, beams, and girders made tight by dressing the lumber true to edge, forming square or butt joints; tight joints in floor and wall panels obtained by using tongue-and-grooved stock;
- sizes of lumber used are: **2-in.stock** for columns, beams and girder bottoms; **1-in. stock** for floor panels and beam and girder sides; **2x4s** for struts, posts, shores, and uprights; **1 or 2-inch stock** for cleats;
- **crude oil and petroline** are used to prevent concrete from adhering to the wood and preserve the forms against damage by alternate wetting and drying; on forms against surfaces which are to be plastered, wetting with water will be sufficient since oiling prevents adhesion of the plaster;
- **wire ties or bolts and rods** are used to hold wall forms together; rods are preferred and should be arranged that upon removal of the forms, no metal shall be within one inch of any surface; wire ties should be used only on light and unimportant work where discoloring will not be objectionable;
- plywood forms used where a smooth surface is required; should be **waterproof**, **Grade "A"** and **at least 1/2" thick**.

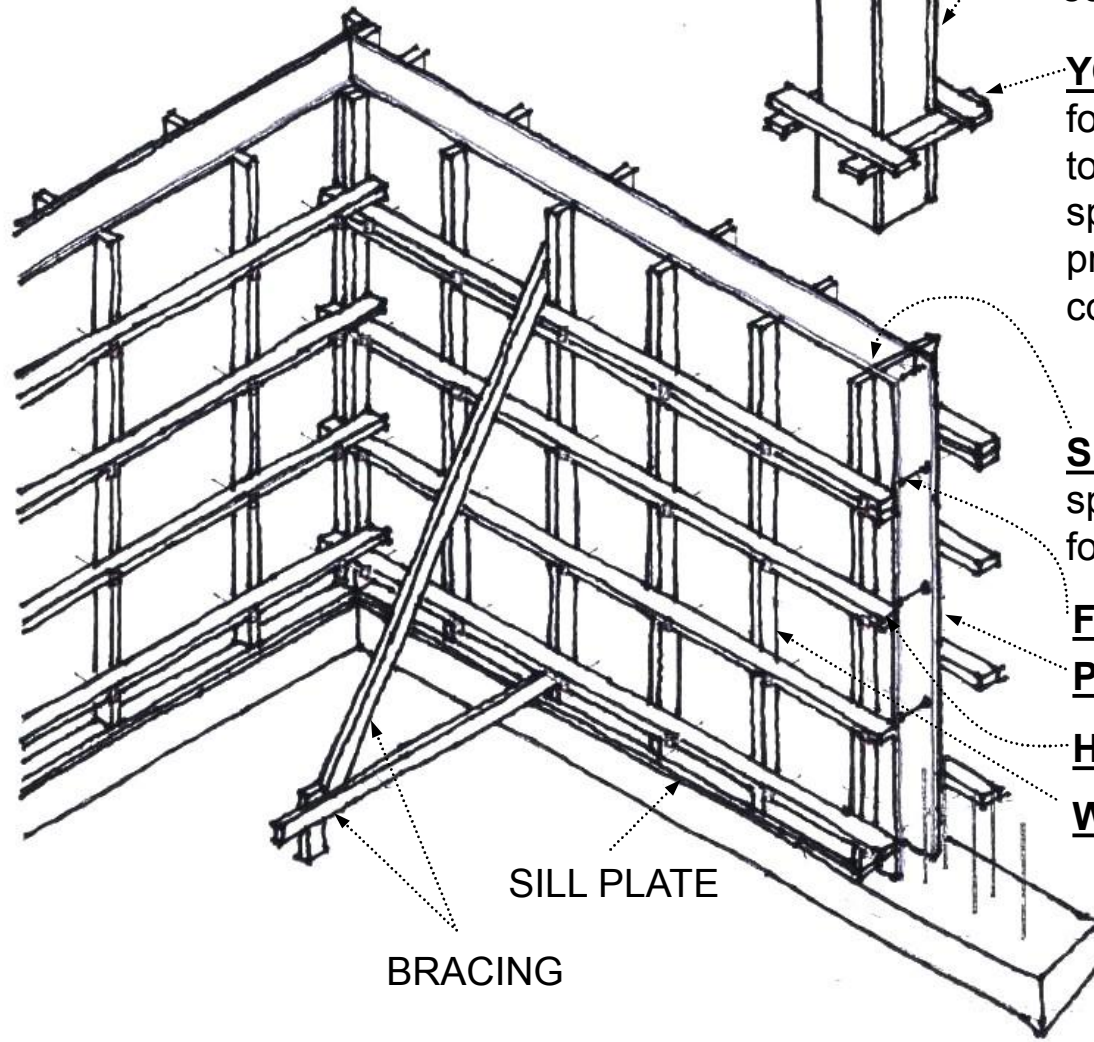
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COLUMN FORMS

WOOD FORMWORKS

Reusable forms may have a square or rectangular cross section

YOKES are clamping devices for keeping column forms and tops of wall forms from spreading under the fluid pressure of newly placed concrete

WALL FORMS

SPREADERS usually of wood, space and keep the wall or forms apart

FORM TIES

PLYWOOD SHEATHING

HORIZONTAL WALERS

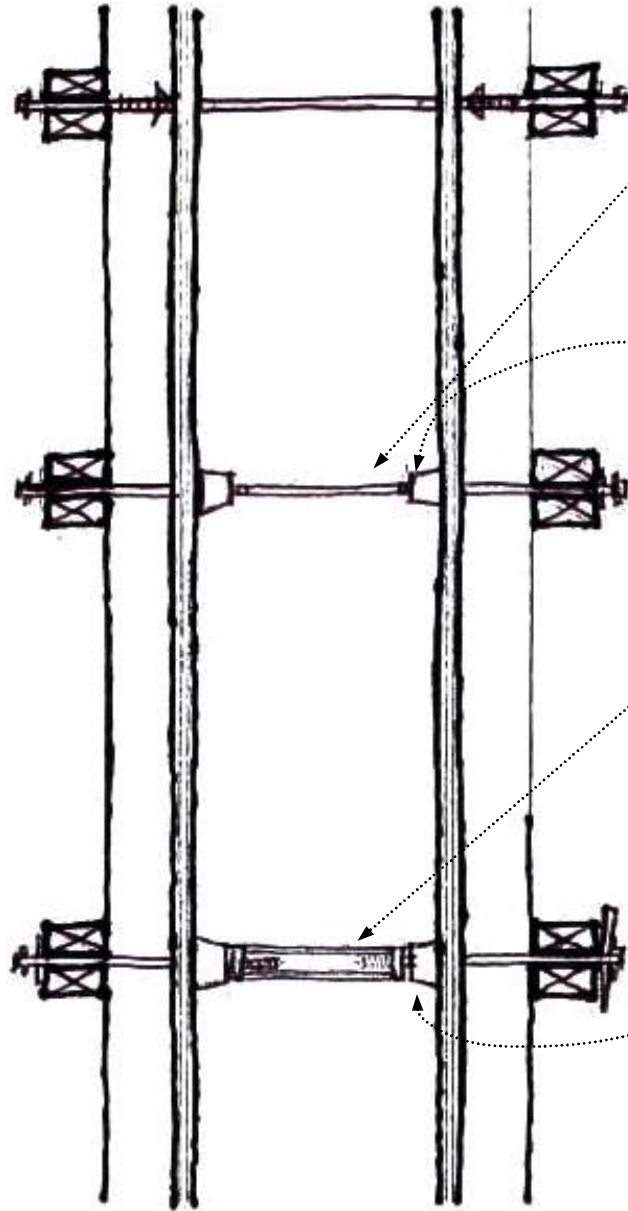
WOOD STUDS

SILL PLATE

BRACING

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FORM TIES

SNAP TIES have notches or crimps that allow their ends to be snapped off below the concrete surface after stripping off the forms

small, truncated cones of wood, steel or plastic attached to form ties to space and spread wall forms, leave a neatly finished depression in the concrete surface to be filled or left exposed

SHE BOLTS consist of **waler rods** that are inserted through the form and threaded onto the ends of an inner rod. After stripping, the waler rods are removed for reuse while the inner rod remains in the concrete

a variety of wedges and slotted devices tighten the formwork and transfer the force in a form tie to the walers

Steel Forms and Shoring

Shoring is also used to support scaffolding works. **Scaffolds** are temporary platforms designed to support workers and materials on the face of a structure and to provide access to work areas above the ground. Any elevated platform is called a scaffold.

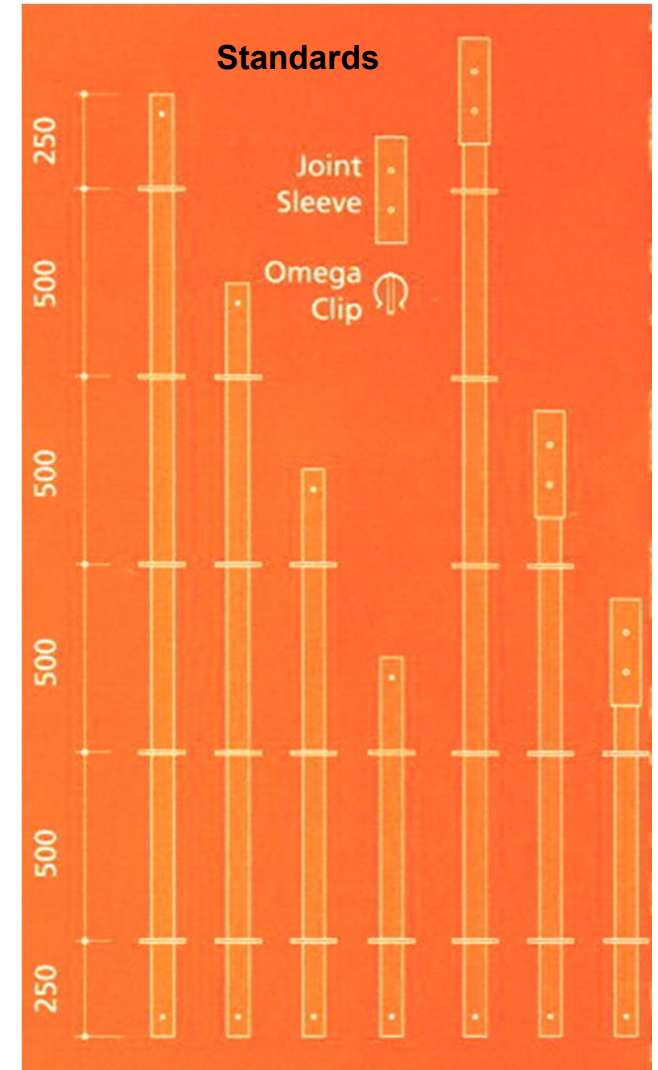
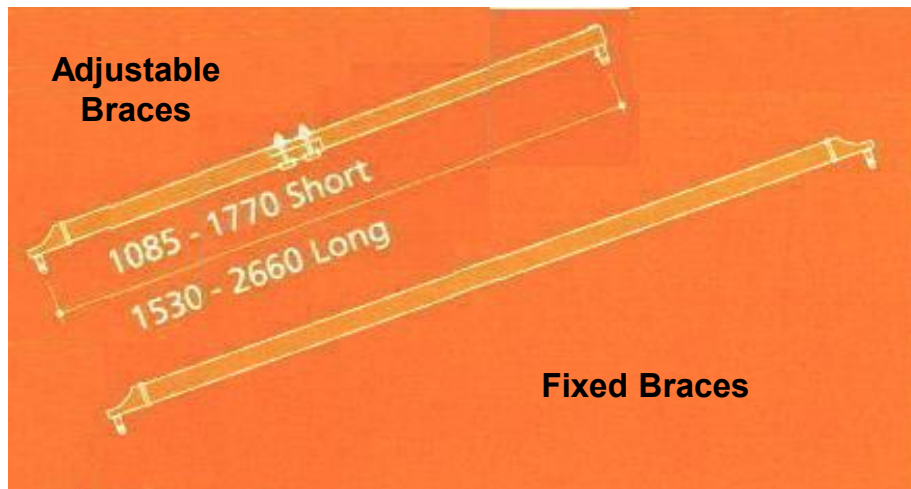
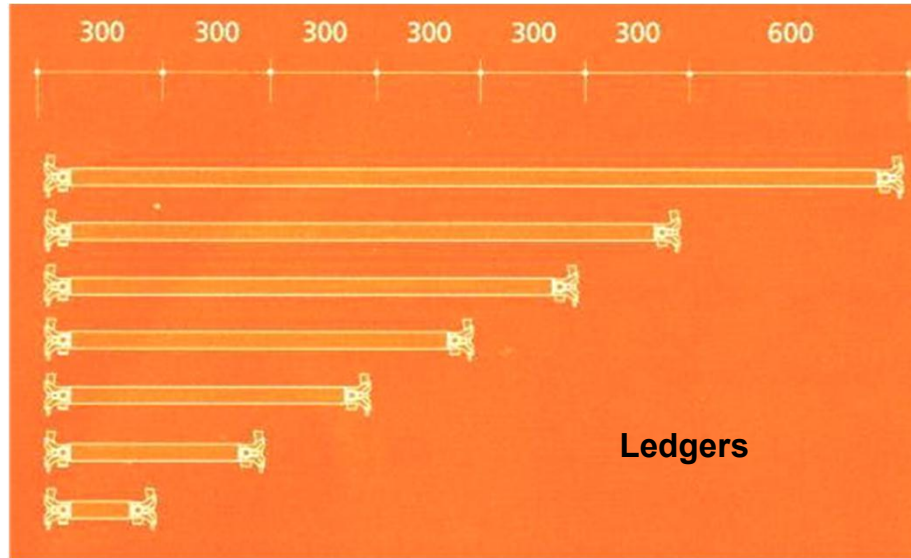
The major components of metal shoring are:

- a) The **ledger** or the horizontal brace
- b) The **brace or the diagonal**. This component may be of the adjustable and the fixed type.
- c) The **standard** or the vertical component.
- d) Accessories: **heads, jacks and bases**.

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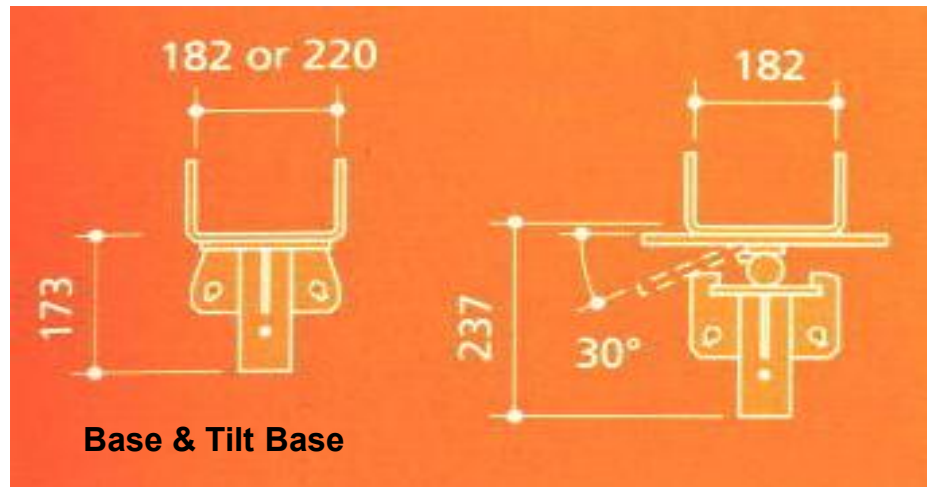
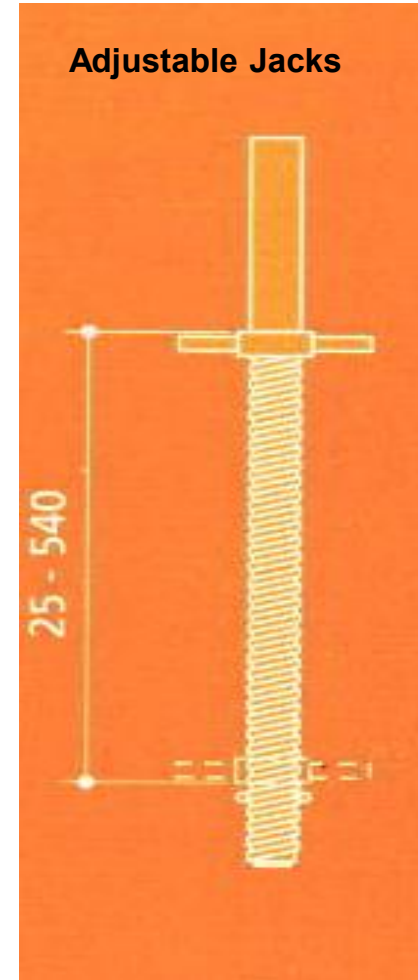
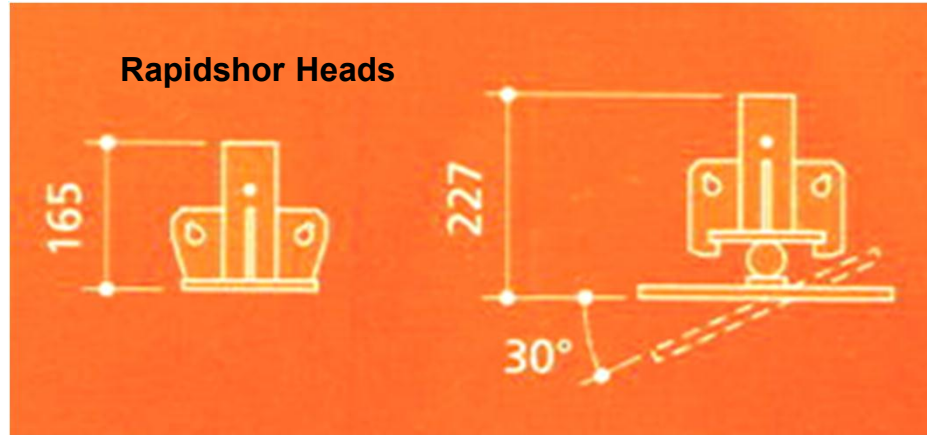
SHORING COMPONENTS



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SHORING COMPONENTS



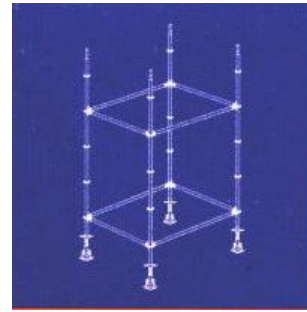
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SHORING ASSEMBLY INSTRUCTIONS

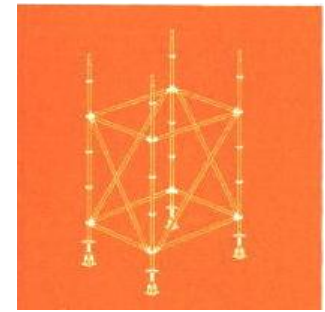
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1. Ensure the ground and sleepers are adequately prepared, and the base, jacks and standards are in correct positions.



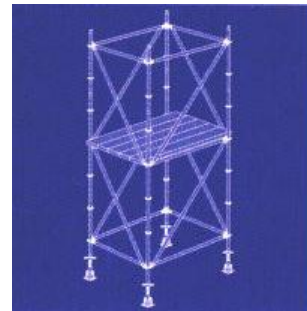
2. Assemble tower of 4 standards and ledgers. Fix braces to stabilize.



3. Loosely fit the remaining components until majority of first level complete. Check standards for verticality and tighten ledgers.



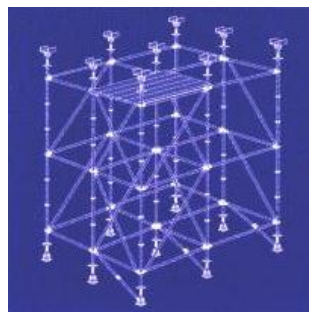
4. Position scaffold boards and ladders.



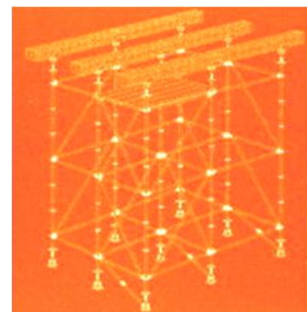
5. Additional ledgers and braces can now be added, with additional braces.



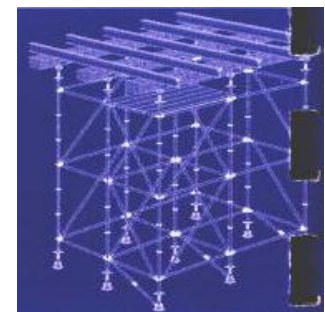
6. Once all levels are complete, jacks and heads can now be positioned.



7. Jack head levels finalized and any jack bracing required is now fitted.



8. Primary beams can be positioned, clamped and levels checked.



9. Secondary beams can be positioned and clamped to primary beams, plywood decking to follow.

CONSTRUCTION TOOLS & EQUIPMENT

Tools and equipment employed in construction are grouped into four:

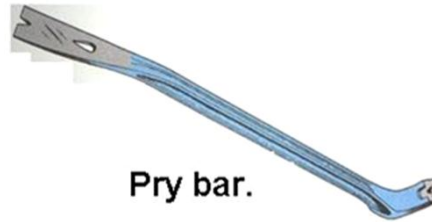
1. **Hand Tools** are the tools that use power delivered by man only.
2. **Power Tools** are those that employ power supplied by forces other than that coming from humans.
3. **Equipment** is a term that refers to large, complex tools and machines that is designed to do a particular job.
4. **Heavy Equipment** is equipment which is very large and very powerful.

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Hand Tools

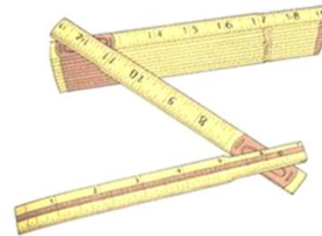
A **pry bar** is used to force open boards used in forming concrete.



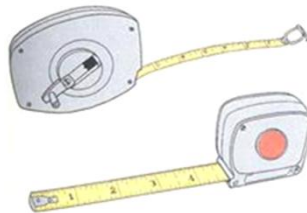
Pry bar.

Measurement and layout tools are the following:

a. **Folding rule** and tape measure are the most common tools for measuring boards, pipe, wire, etc.



Folding rule.



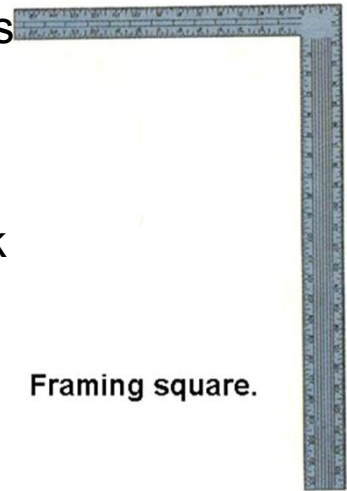
Tape measures.

b. **Digital rule** is used to measure relatively long distances such as those in highway construction.



Digital rule.

c. **Framing square** is a layout tool that is used to measure 90-degree angles at the corners of framework and joints. They can also be employed to determine cutting angles on dimension lumber.



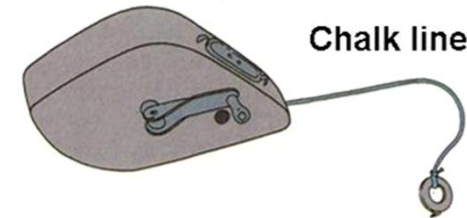
Framing square.

d. **Level** is a long, straight tool that contains one or more vials of liquid and used to determine if the horizontal or vertical is exact.



Level.

e. **Chalk line** or chalk box is used for marking lines.



Chalk line.

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Types of hammers are the following:

a. **Claw hammer** is an ordinary hammer used to drive or remove nails.



Claw hammer.

b. **Sledgehammer** is a heavy hammer used to drive stakes into the ground and to break up concrete and stone.



Sledgehammer.

Types of screwdrivers are:

a. **Standard screwdriver** has a flat tip and is designed to fit a standard slotted screw.



Standard screwdriver.

b. **Phillips screwdriver** has an X-shaped tip and is used to turn Phillips-head screws only.



Phillips screwdriver.

c. **Spiral ratchet screwdriver** is that which relies on a pushing force rather than a twisting force.

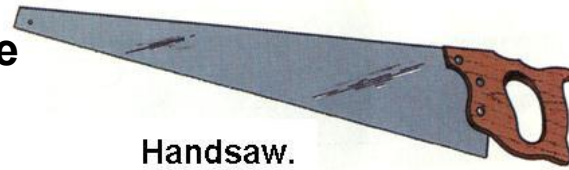


Spiral ratchet screwdriver.

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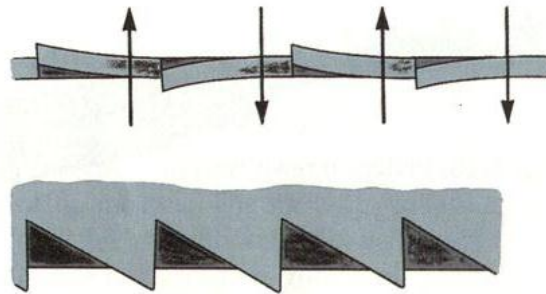
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Types of handsaws are the following:



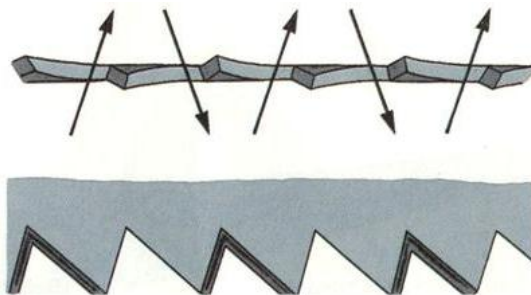
Handsaw.

a. **Ripsaw** has chisel-like teeth designed for ripping or cutting with the grain of wood.



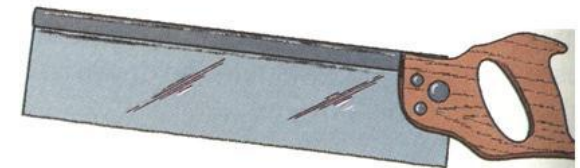
Ripsaw blade. Top, top view.
Bottom, side view.

b. **Crosscut saw** is used to cut across the grain of wood.



Crosscut-saw blade. Top, top view.
Bottom, side view.

c. **Backsaw** is a special type of handsaw that has a very thin blade and makes very straight cuts such as those on trims and mouldings.



Backsaw

d. **Hacksaw** is used to cut metals.



Hacksaw

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Types of Chisels:

a. **Wood chisel** is used to trim wood and clear away excess material from wood joints.



Wood chisel.

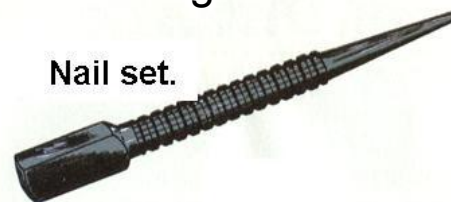
b. **Cold chisel** is used to trim metals.



Cold chisel.

Types of specialized hand tools are the following:

a. **Nail set** is used to drive finishing nails below the surface of a wooden trim or molding.



Nail set.

b. **Pipe wrench** is used to turn round objects like pipes.



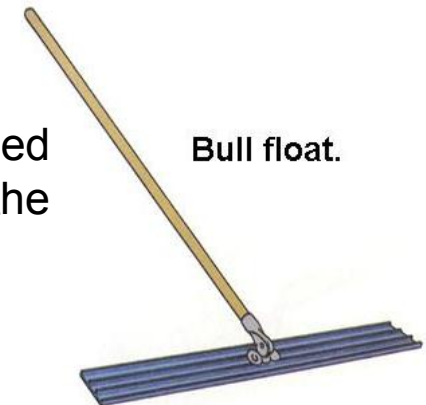
Stillson (pipe) wrench.

c. **Brick trowel** is used to place and trim mortar between bricks or concrete blocks.



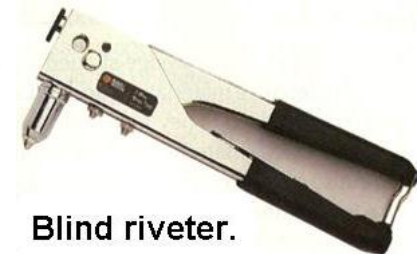
Brick trowel.

d. **Bull float** is used to smoothen out the surface of wet concrete.



Bull float.

e. **Blind riveter** is used to fasten pieces of sheet metal together.



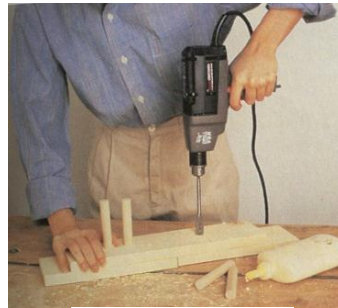
Blind riveter.

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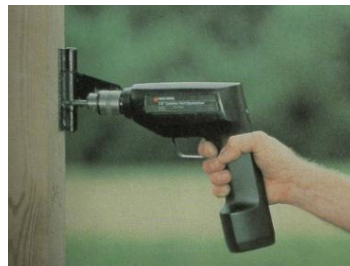
2. Power Tools

Power drill is used to drill holes in wood, metal and concrete.



Power drill.

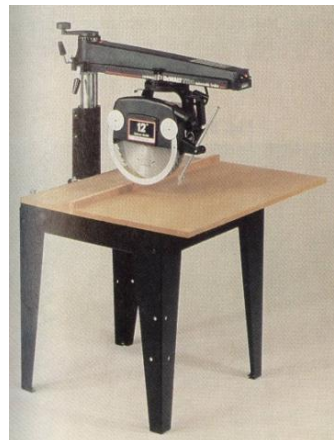
Power screwdriver or **screwgun** is used to install and remove screws.



Power screwdriver.

Types of power saws are the following:

a. **Radial arm saw** is used for crosscutting wood and consists of a motor-driven saw blade that is hung on an arm over a table.



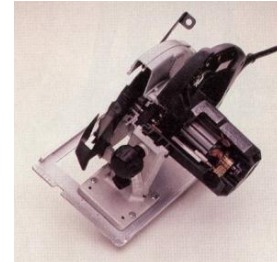
Radial arm saw.

b. **Table saw** is used for cutting large sheets of wood and wood composites and consists of a blade mounted on an electric motor beneath a table-like surface.



Table saw.

c. **Portable circular saw** is used for cutting materials that are difficult to cut with stationary tools.



Portable circular saw.

d. **Power miter saw** is a circular saw mounted over a small table used to cut various angles in wood.



Power miter saw.

e. **Saber saw** is used to cut curves or holes in floors and roofs for pipes and has a small knife-shaped blade that moves up and down.



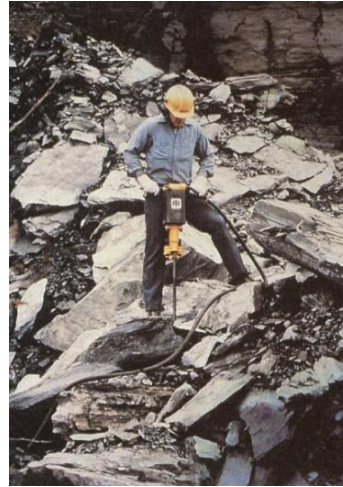
Saber saw.

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Type of power hammers are:

a. **Pneumatic hammer** or jackhammer is used to break up concrete or asphalt paving.



Pneumatic hammer.

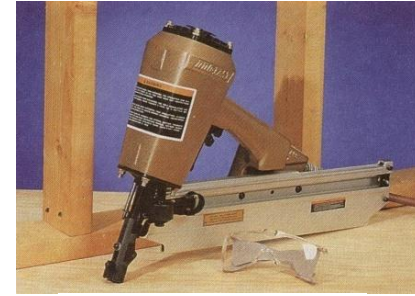
b. **Rotary hammer** is like an electric drill that operates with both rotating and reciprocating actions and is used to drill holes in concrete.



Rotary hammer.

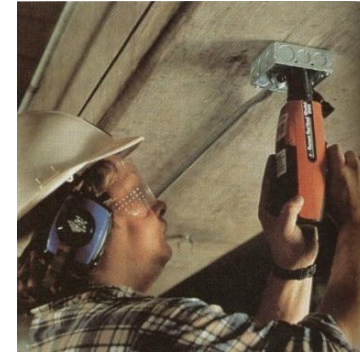
Type of power nailers and staplers are the following:

a. **Nailers** or **nail guns** fasten materials together by shooting nails into the building material.



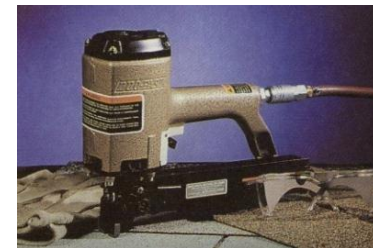
Pneumatic nailer

b. **Powder-actuated stud driver** is a kind of nailer that is powered by gunpowder and is used to drive long pins into wood, steel or concrete.



Powder-actuated stud driver.

c. **Staplers** are like nailers but are loaded with u-shaped staples instead of nails for fastening.



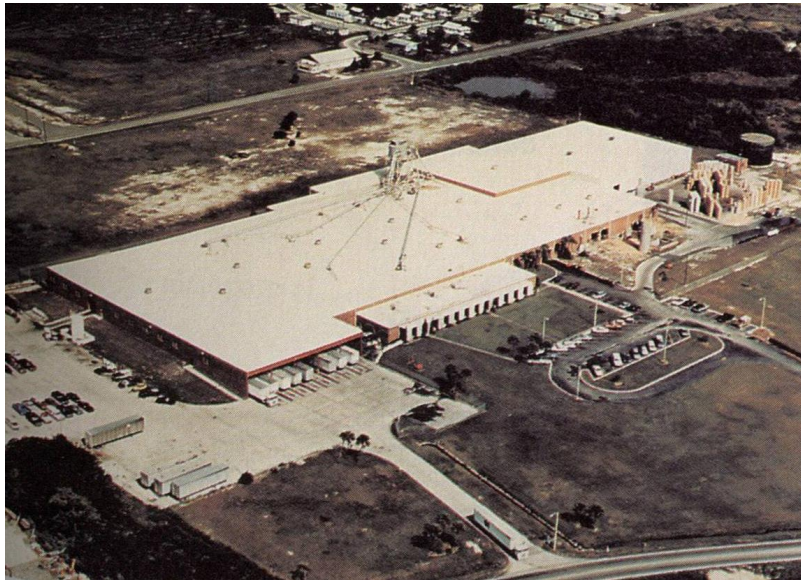
Stapler.

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3. Equipment

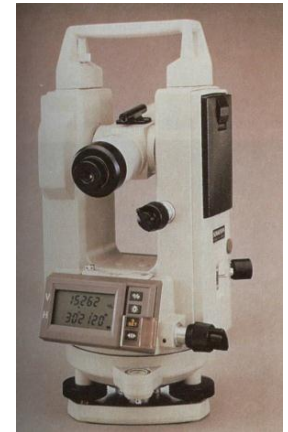
Conveyor is an equipment which moves materials other than fluids.



Conveyors are used for transporting materials onto large roofs.

Types of surveying equipment:

a. **Transit** is an equipment used by surveyors to measure horizontal and vertical angles to obtain land elevation.



Transit.

b. **Surveyor's level** is that which is used to determine an unidentified elevation from a known one.



Surveyors level.

c. **Construction laser** flashes a narrow, accurate beam of light to make a baseline for additional measurements and is used as a level or as an alignment tool.



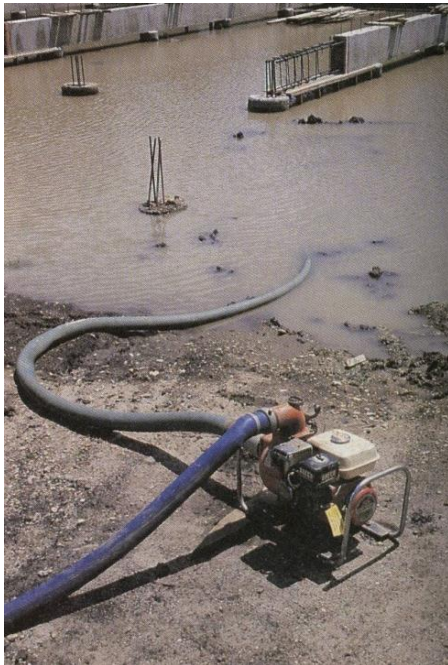
Construction laser.

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Types of pumps are:

a. **Water pump** is used to pump water out of holes in the ground so that construction work can commence.



Water pump.



Concrete pump.

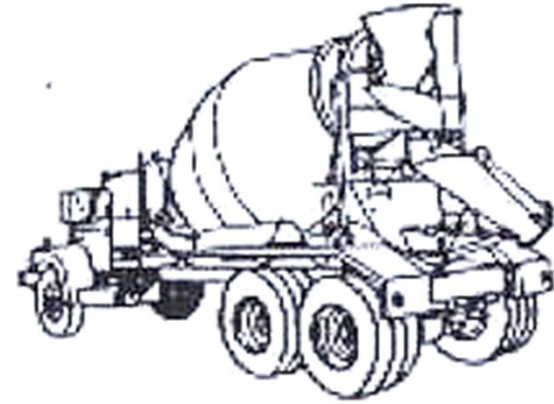
b. **Concrete pump** is used to move concrete from the concrete mixer to the concrete form.

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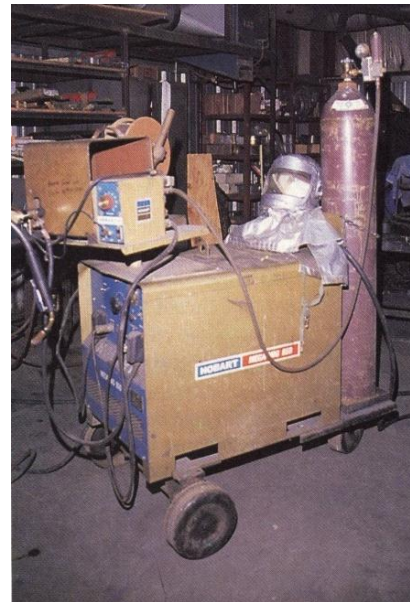
Concrete Mixer (Cement Mixer)

A machine that mixes concrete ingredients by means of a rotating drum. Raw materials are introduced into the mixing drum through its open end and discharged by tilting the mixing drum to allow the concrete to pour out.



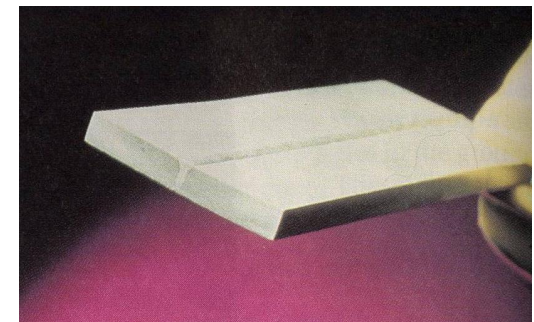
Types of welding machines are the following:

a. Arc welding machine is used to weld materials by melting portions of the metal.



Arc welding machine.

b. Laser-powered welder is used to weld material by employing a laser to heat the metal.



Weld made by a laser-powered welder.

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4. Heavy Equipment

Bulldozer is a tractor with a pushing blade which moves earth and clears land of bushes and trees.



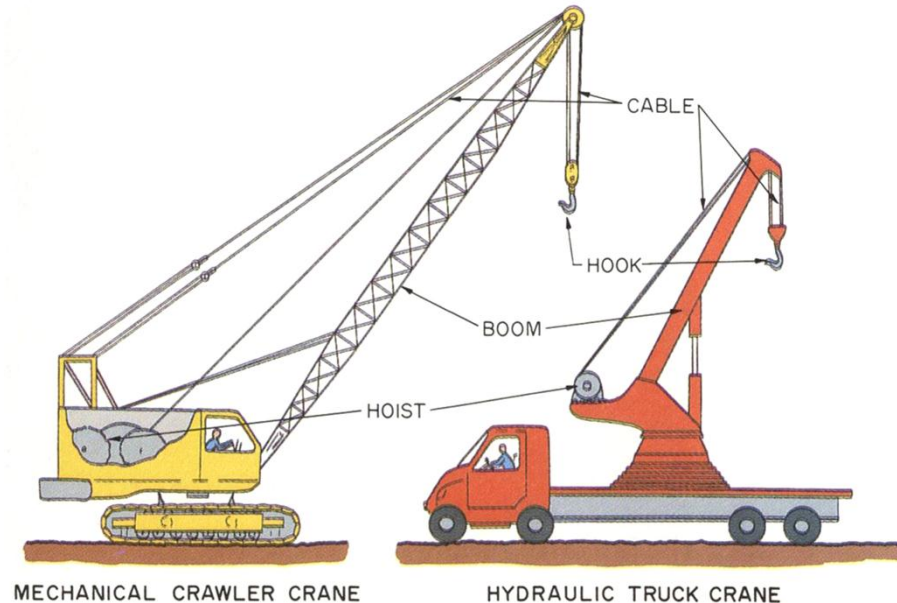
Bulldozer.

Cranes are machines that lift large and heavy materials. The types of cranes are:



640-foot crane.

a. **Crawler crane** is a crane mounted on metal treads so that it can move over rough terrain.



b. **Truck crane** is mounted on a truck frame so that it can be driven in the site.

c. **Tower crane** or climbing crane is used in the construction of tall building because it has a built-in jack that raises the crane from floor to floor as the building is constructed.

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Excavator is a machine used for digging or scooping earth from a place and depositing it in another.

Types of excavators are:

a. **Backhoe** is used for general digging which is usually mounted on either a crawler or truck frame.

b. **Trencher** is a special kind which digs trenches or long, narrow ditches for pipelines or cables.

c. **Front-end loader** is a large shoveling machine that can scoop or deposit a large amount of material.



Backhoe.



Trencher-excavator.



Front-end loader.

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Highway construction equipment are:

a. **Scraper** is a machine that loads, hauls and dumps soil over medium to long distances.

b. **Grader** is an earthworking machine that grades or levels the ground.

c. **Compactor** or **roller** is a machine that compacts soil to prepare for road paving.

d. **Paver** is a machine that places, spreads and finishes concrete or asphalt paving material.



Scraper.



Grader.

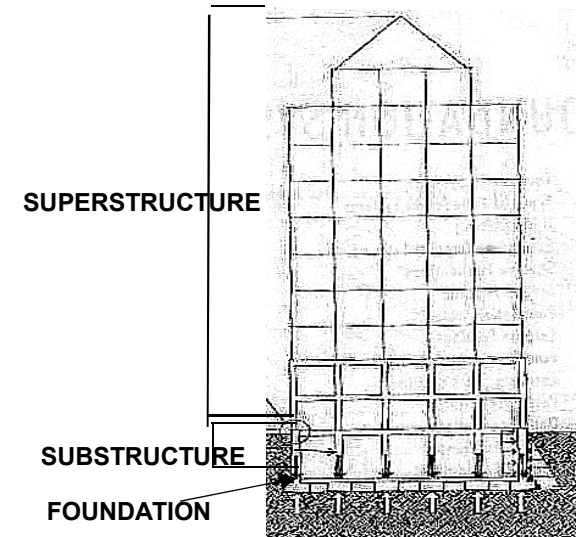


Compactor

1.5 MAJOR PARTS OF A BUILDING

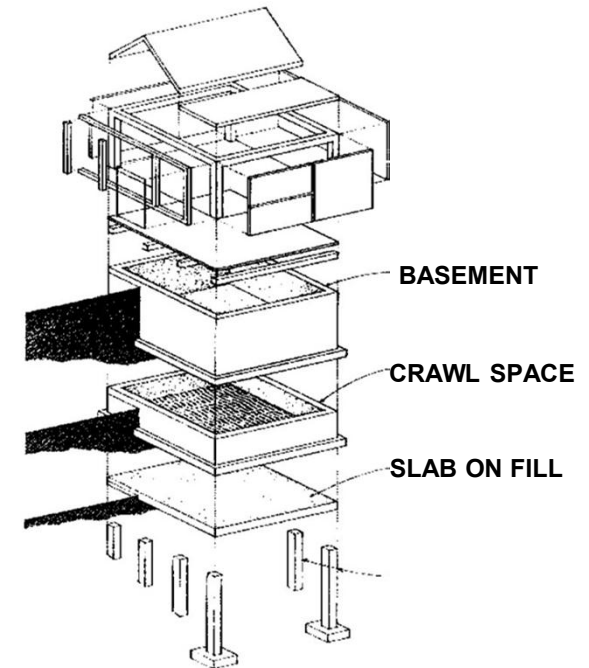
The major parts of a building are:

1. **Superstructure** – the portion of the building above the ground.
2. **Substructure** – the habitable portion of the building found below the ground.
3. **Foundation** – the structural portion of the building that transfer the buildings load into the soil.



The three types of substructures are:

1. **Slab on Fill** – slab which rests on ground and not suspended.
2. **Crawl Space** – in a building without a basement, an unfinished accessible space below the first floor which is usually less than a full story height.
3. **Basement** – the lower story of a building, either partly or entirely below grade.



1.6 FOUNDATION BED

The word **“foundation”** is applied to:

1. **Construction below grade**, such as footing courses, basement walls, etc., forming the lower section of a structure;
2. The **natural material**, the particular part of the earth's surface on which the construction rests;
3. **Special construction** such as piling or piers used to transmit the loads of the building to firm substrata.

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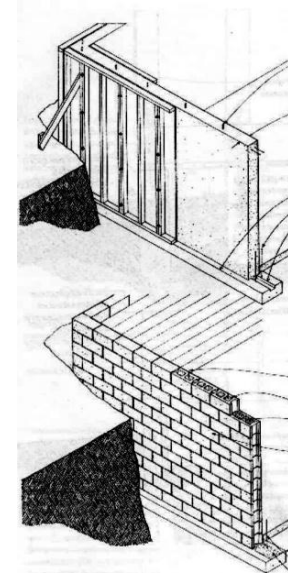
Foundation bed - the natural material on which the construction rests

Foundation walls - that part of the building foundation which forms the permanent retaining wall of the structure below grade.

Foundation piers/columns – piers/columns below grade, to distinguish them from similar construction above grade

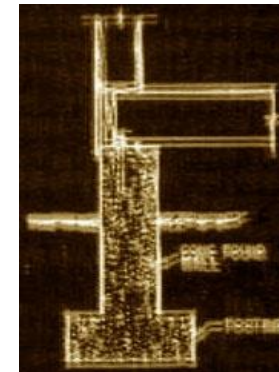
Grade Beam - that part of a foundation system which supports the exterior wall of the superstructure and bears directly on the column footing.

Footing courses - lower portions of walls, piers or columns which are spread to provide a safe base

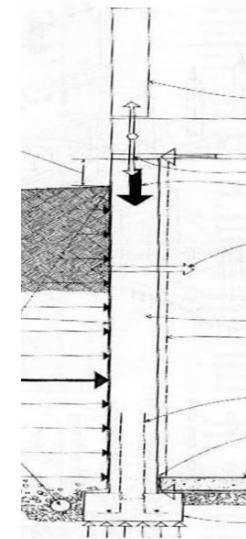


CONCRETE
FOUNDATION WALLS

CONCRETE MASONRY
FOUNDATION WALLS



FOOTING



FOUNDATION WALL

TYPES OF FOUNDATION BEDS

Foundation beds may be classified as follows:

1. **Rock (solid rock, bedrock or ledge).** Undisturbed rock masses forming an undisturbed part of the original rock-formation. Some examples of harder rocks are granite, slate, sandstone, and limestone which are all capable of carrying the load of any ordinary structure. Examples of softer rocks are shale, shaley slates and certain marley limestone and clay stones.
2. **Decayed rock (rotten rock).** Sand, clays and other materials resulting from the disintegration of rock masses, lacking the coherent qualities but occupying the space formerly occupied by the original rock.
3. **Loose rock.** Rock masses detached from the ledge of which they originally formed a part.
4. **Gravel.** Detached rock particles, generally water-worn, rounded and intermediate in size between sand particles and boulders.
5. **Boulders.** Detached rock masses larger than gravel, generally rounded and worn as a result of having been transported by water a considerable distance from the ledges of which they originally formed a part.

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6. **Sand.** Non-coherent rock particles smaller than $\frac{1}{4}$ " in maximum dimension.
7. **Clay.** A plastic material resulting from the decomposition and hydration of feldspathic rocks, being hydrated silicate of alumina, generally mixed with powdered feldspar, quartz and other materials.
8. **Hard-pan.** Any strong coherent mixture of clay or other cementing material with sand, gravel and boulders.
9. **Silt.** A finely divided earthy material deposited from running water.
10. **Mud.** Finely divided earthy material generally containing vegetable matter and deposited from still or slowly moving water.
11. **Mould.** Earthy material containing a large proportion of humus or vegetable matter.
12. **Loam.** Earthy material containing a proportion of vegetable matter.
13. **Peat.** Compressed and partially carbonized vegetable matter.
14. **Filled Ground.** All artificial fills and some natural fills are liable to a more or less uniform but continuous settlement or shrinkage due to the gradual consolidation of the material of which the fill is composed

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ALLOWABLE LOADS ON FOUNDATION BEDS

Thorough investigation is required before one can determine the allowable unit load on the foundation bed. When material and conditions are uniform over the entire site of the building, a uniform unit load may be used. In cases when entirely different conditions exist under different portions of the same building, the unit load on the foundation bed must be reduced as much as possible so as to reduce the differences in settlements between the two sections of the building to a minimum.

SITE INVESTIGATION

Before any design is made, the architect is required to get as much valuable data about site excavation and building erection at the project site in order to determine the character of the materials which will be encountered at the level of a foundation bed.

METHODS OF EXPLORATION

1. **Test pits.** For shallow work, an open pit is the most suitable method since it calls for an actual inspection of the undisturbed material over a considerable area.
2. **Test borings.** For excavations that are carried no deeper than the proposed level, the underlying material may be investigated by test boring.



Soil Boring Rig.



SPT Sample.

LOADING TESTS

Loading tests of the materials forming the foundation bed are made to assist in determining its safe bearing capacity.

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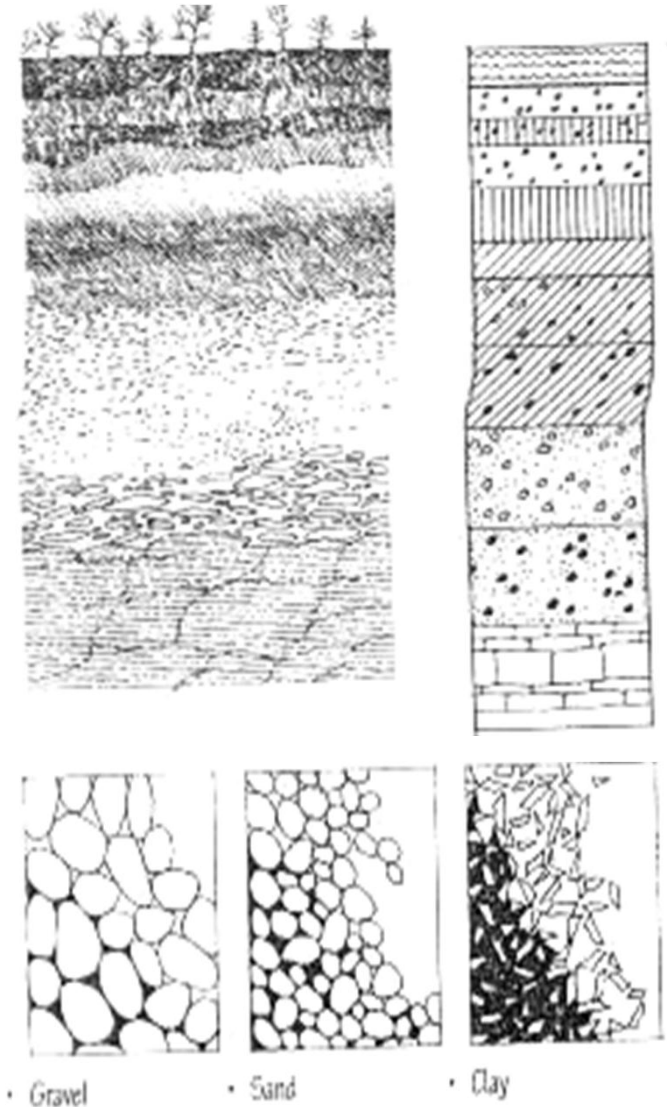
SOIL MECHANICS

1.8.1 CLASSES OF SOIL

There are two broad classes of soil:

- A. Course-grained soil** – consist of relatively large particles, visible to the naked eyes.

- B. Fine-grained soil** – consist of much smaller particles, such as silt and clay.



SOIL TYPE & CAPACITY

SOIL TYPE	Presumed Bearing Capacity		Susceptibility to Frost Action	Drainage (permeability)
	(tons/ft ²)	(kg/m ²)		
Compact, partially cemented gravels, well-graded with little or no fines	10	97 650	none	excellent
Compact gravel; gravel and sand mixtures	6	58 590	None	excellent
Coarse, compact sand; loose gravel; hard, dry clay	4	39 060	Slight	Fair to good
Coarse, loose sand and gravel mixtures; fine, compact sand	3	29 295	Slight	Fair to good
Fine, loose sand; dry, stiff clay	2	19 530	High	Fair to poor
Soft clay; soft, broken shale	1.5	14 648	High	poor
Organize soils	Unsuitable as a foundation material; can be highly unstable due to bacterial decomposition and changes in moisture content.			

STABILITY AND STRENGTH OF SOIL BED

is defined by the following criteria:

- A. Allowable Bearing Capacity – maximum unit pressure a foundation is permitted to impose vertically or laterally on the soil mass.
- B. Density – the critical factor determining the bearing capacity of granular soils.
 - SPT - Standard Penetration Test
 - measures the density of granular soils and the consistency of some clays
 - records the number of blows required by a hammer to advance a standard soil sampler.
 - MDD - Maximum Dry Density
 - Dry density is the density of soil, or the like, after it has been heated at a temperature of 221 deg F (105 deg C) to a dry condition.
- C. Shearing Strength – measure of the ability to resist displacement when an external force is applied, due largely to the combined effects of cohesion and internal friction.
- D. Water Table – level beneath which the soil is saturated with groundwater.

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EXCAVATION AND EARTHWORKING

These processes entail the following:

1. **Excavating** is the process of digging the earth to provide a place for the foundation of the building.

2. **Leveling and Grading** are processes that change land elevation and slope by filling in low spots and shaving off high spots.

3. **Stabilizing the Soil** is the process of compacting the soil on which the structure will rest.

4. **The protection of adjoining structure** is a law that provides that any person making an excavation is responsible for resulting damage to adjoining property.



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5. **Shoring** is a process of transferring a portion of the load of the wall to temporary footings and done when the excavation does not go much below the adjoining footings and when the material is fairly solid.

It consists of the following members:

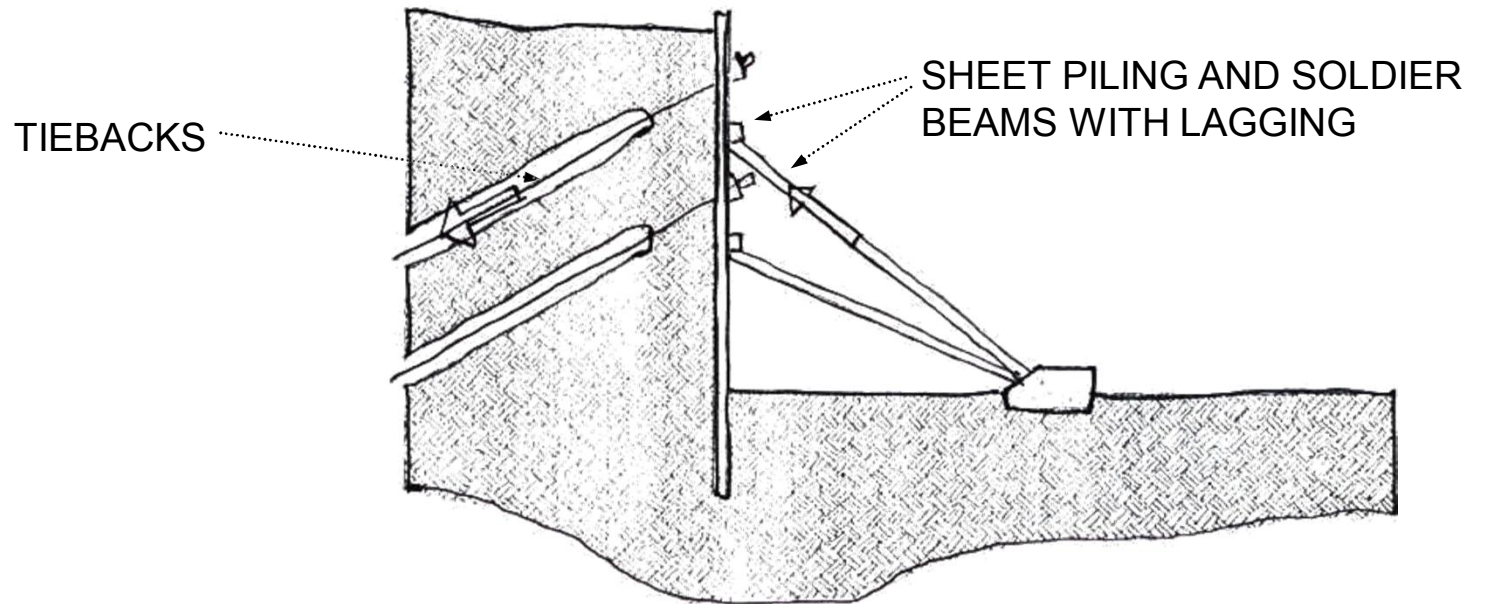
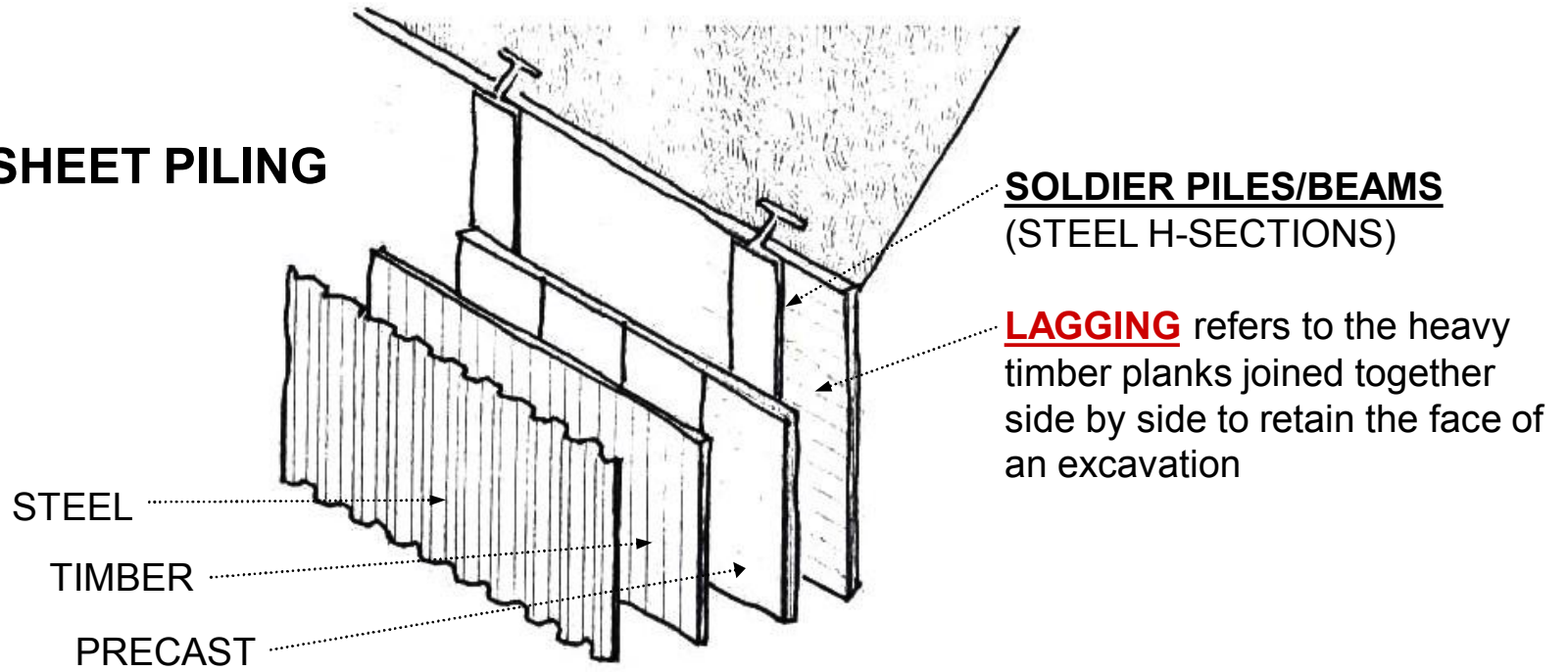
- a) **sheet piles**, which are timber, steel, or pre-cast planks driven side by side to retain earth and prevent water from seeping into the exaction and
- b) **wales** or continuous horizontal beams which tie the sheet piles in place or
- c) **soldier piles**, which are steel H-sections driven vertically into the ground to support
- d) **lagging** or heavy timber planks joined together horizontally to retain the face of an excavation.
- e) **crossbracing** or **rakers** are diagonals which support the wales and soldier piles bearing on **heel blocks** or footings.
- f) **tiebacks** secured to rock or soil anchors are resorted to when crossbracing or rakers would interfere with the excavation procedure.



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SHEET PILING



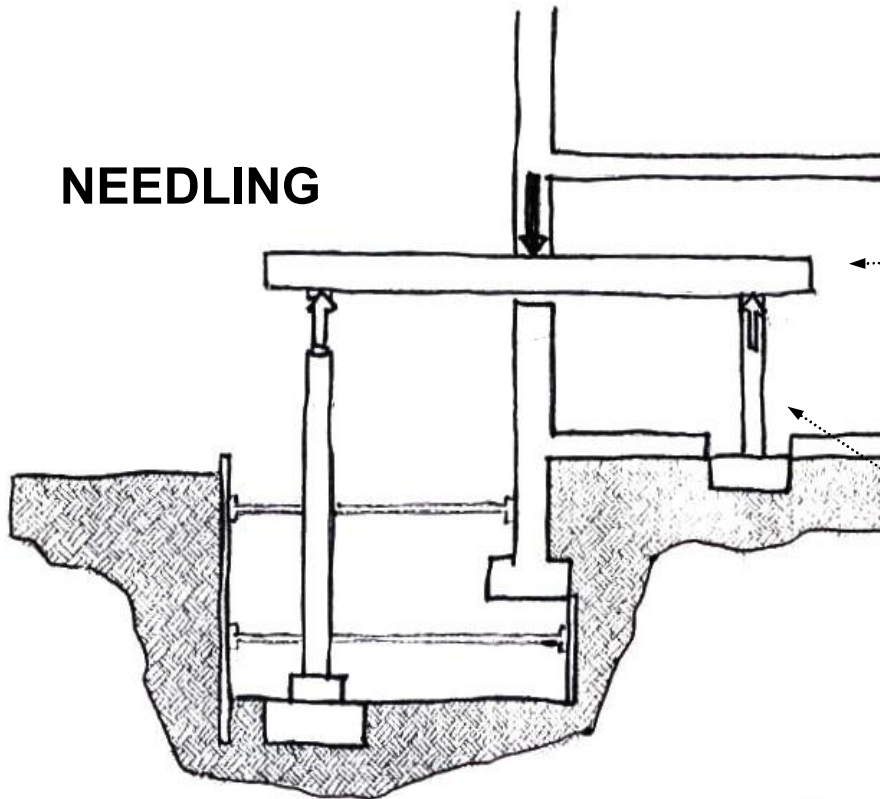
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6. **Needling and underpinning** is a process where needles or girders are used in cases where part or all of the weight of the wall has to be carried, as when the old footing is removed and the wall underpinned or carried down to a new footing at a greater depth.



NEEDLING



NEEDLE; a short beam passed through a wall as a temporary support while the foundation or part beneath is repaired, altered or strengthened

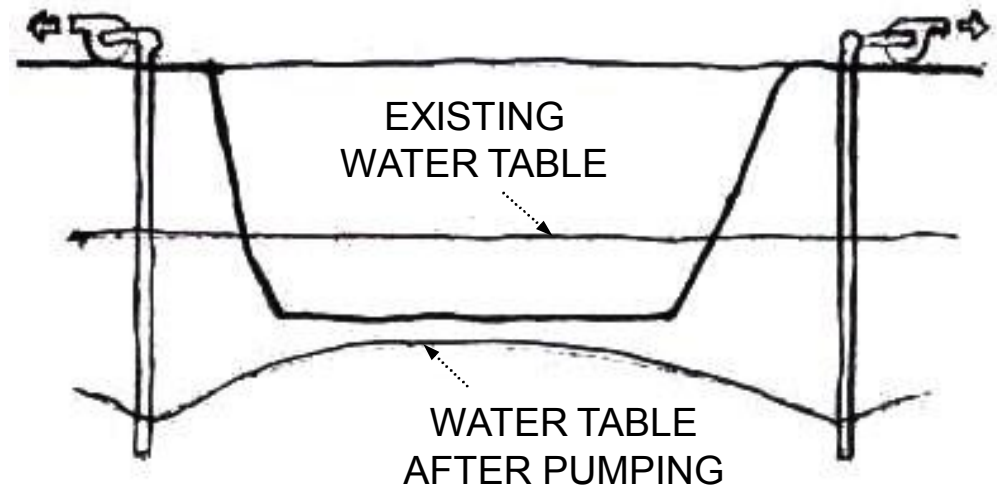
DEAD SHORE; an upright timber for supporting a dead load during the structural alteration of a building, esp. one of two supports for a needle

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7. **Dewatering** refers to the process of lowering a water table or preventing an excavation from filling with groundwater. It is accomplished by driving perforated tubes called wellpoints into the ground to collect water from the surrounding area so it can be pumped away.

DEWATERING



SITE DRAINAGE

- necessary to prevent erosion and collection of excess surface water or groundwater resulting from new construction.

Surface Water –

1. Rainfall which runs over the surface of the ground.
2. Water carried by an aggregate except that held by absorption within the aggregate particles themselves.

Groundwater –

Water, near the surface of the ground, which passes through the subsoil.

BASIC TYPES OF SITE DRAINAGE

A. SUB-SURFACE DRAINAGE –

consists of an underground network of piping for conveying groundwater to a point of disposal, as a storm sewer system or a natural outfall at a lower elevation on the site. Excess groundwater can reduce the load-carrying capacity of a foundation soil and increase the hydrostatic pressure on a building foundation. Waterproofing is required for basement structures situated close to or below the water table of a site.

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Components of the sub-surface drainage system are:

Catch Basins

receptacles for the runoff of surface water. They have a basin or sump that retains heavy sediment before it can pass into an underground drainpipe.

Culverts

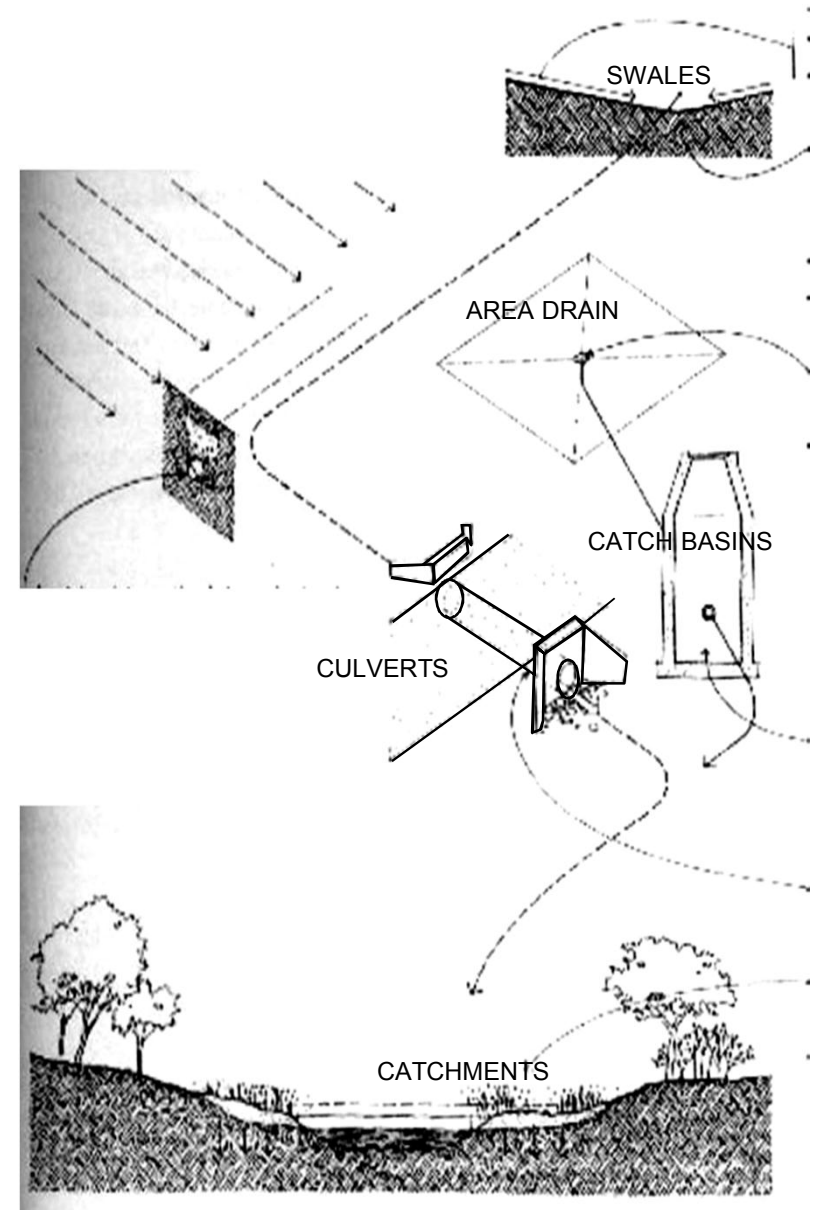
are drains or channels passing under a road or walkway.

Foundation drainage tile or pipe

Tile or piping for the collection of sub-surface water, dispersion of septic tank effluent, and the like.

Drainage tile

is a hollow tile, usually laid end to end as piping (with open joints) in soil in order to drain water saturated soil, or used to permit fluid in the hollow-tile pipe to disperse into the ground (as in an absorption field).



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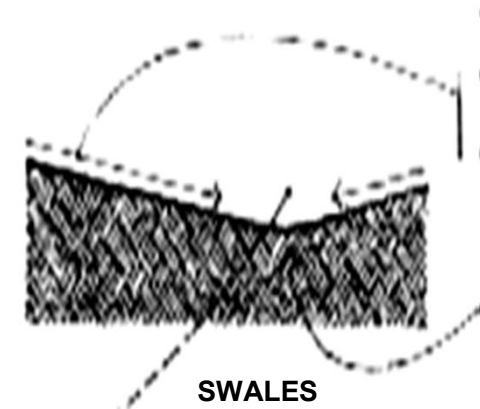
B. SURFACE DRAINAGE

refers to the grading and surfacing of a site in order to divert rain and other surface water into natural drainage patterns or a municipal storm sewer system. **Grass and lawn areas are sloped 1.5% to 10%; while paved parking areas, 2% to 3%.** A holding pond may be necessary when the amount of surface runoff exceeds the capacity of the storm sewer system.

Components of the surface drainage system are:

Swales

shallow depressions formed by the intersection of two ground slopes, designed to direct or divert the runoff of surface water. Grass swales slope 1.5% to 2%; while paved swales, 4% to 6%.



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Area Drain

receptacle designed to collect surface water or rainwater from an open area.

Dry Wells

are drainage pits lined with gravel or rubble to receive surface water and allow it to percolate away to absorbent earth underground. Also called an absorbing well.



DRY WELL

Ponds and Marshes

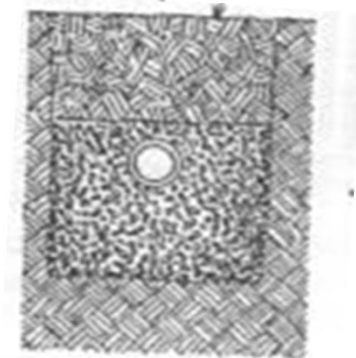
designed catchments areas for surface water.

Absorption Field or Disposal Field

a system of trenches containing coarse aggregate and distribution pipes through which septic-tank effluent may seep into the surrounding soil.

Absorption Trench

a trench containing coarse aggregate and a distribution tile pipe through which septic-tank effluent may flow, covered with earth.



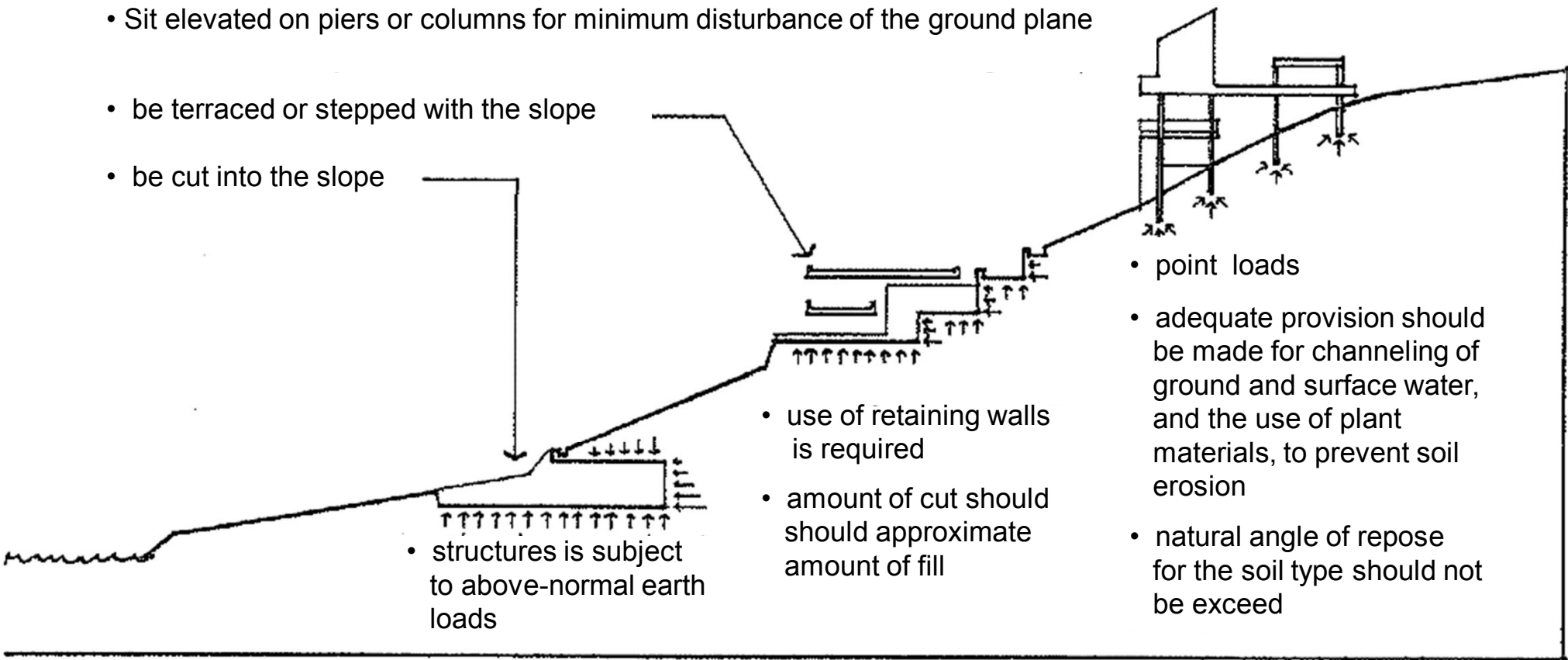
ABSORPTION TRENCH

TOPOGRAPHY AND BUILDING FORM



STEEP SLOPES : STRUCTURES

- Sit elevated on piers or columns for minimum disturbance of the ground plane
- be terraced or stepped with the slope
- be cut into the slope



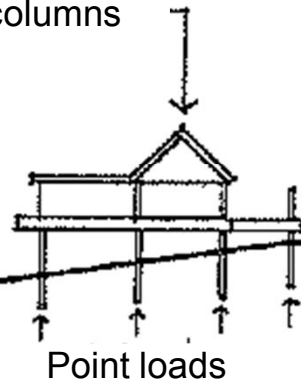
- use of retaining walls is required
- amount of cut should approximate amount of fill

- point loads
- adequate provision should be made for channeling of ground and surface water, and the use of plant materials, to prevent soil erosion
- natural angle of repose for the soil type should not be exceed



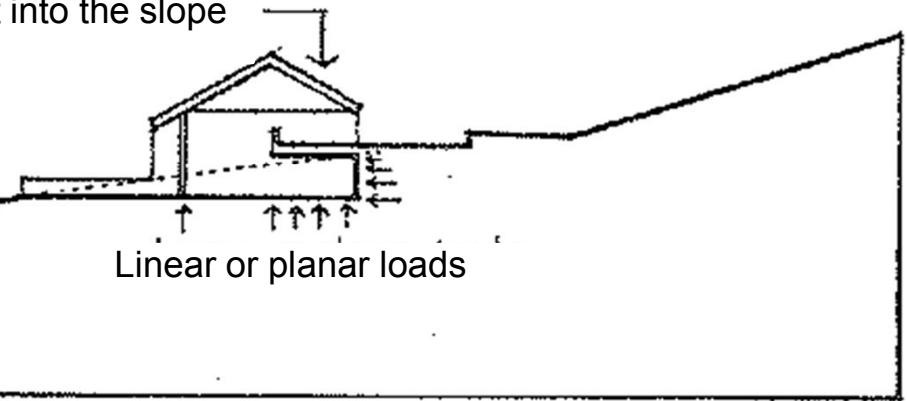
MODERATE SLOPES: structures

- be elevated on piers or columns



Point loads

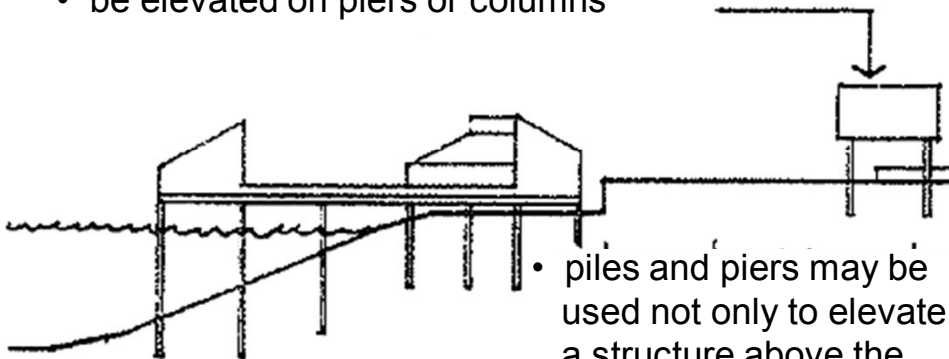
- be cut into the slope



Linear or planar loads

FLAT SLOPES: structures may

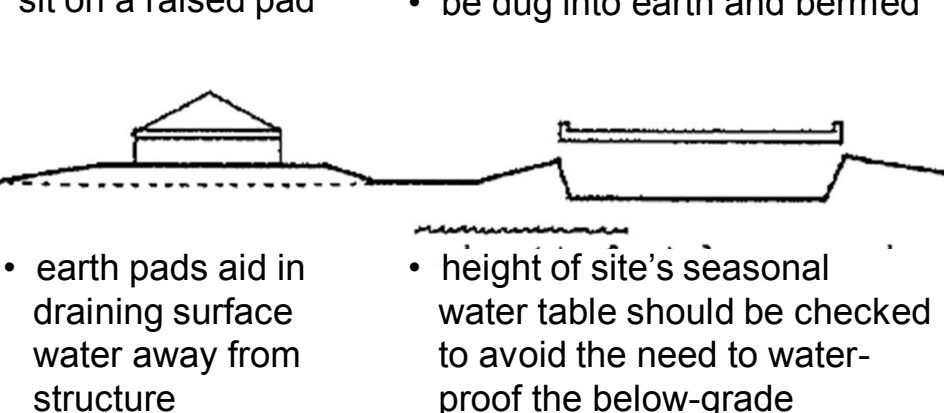
- be elevated on piers or columns



- structures over water may be supported by floatation or on caissons or piles resting on a sub-surface base

- piles and piers may be used not only to elevate a structure above the ground plane but also to support structures situated over unstable bearing soil

- sit on a raised pad



- earth pads aid in draining surface water away from structure

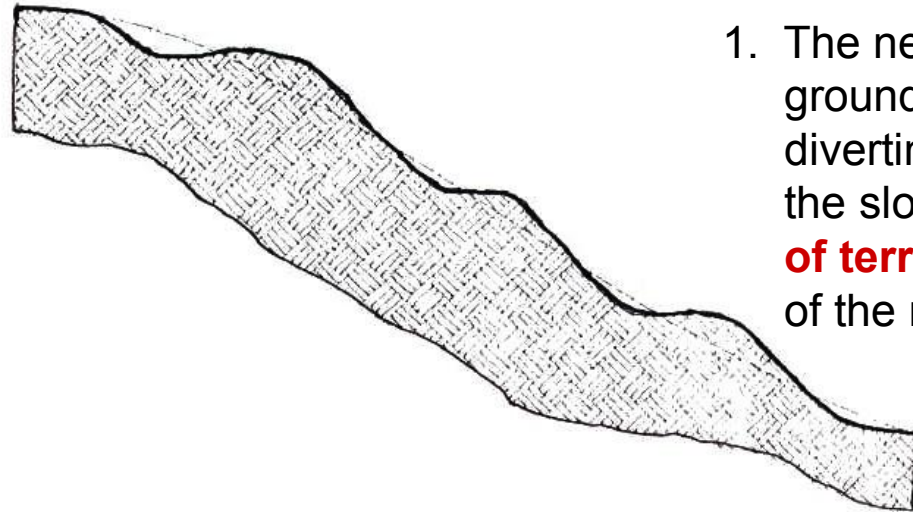
- be dug into earth and bermed

- height of site's seasonal water table should be checked to avoid the need to waterproof the below-grade structure
- earth berms may act as the building's side walls

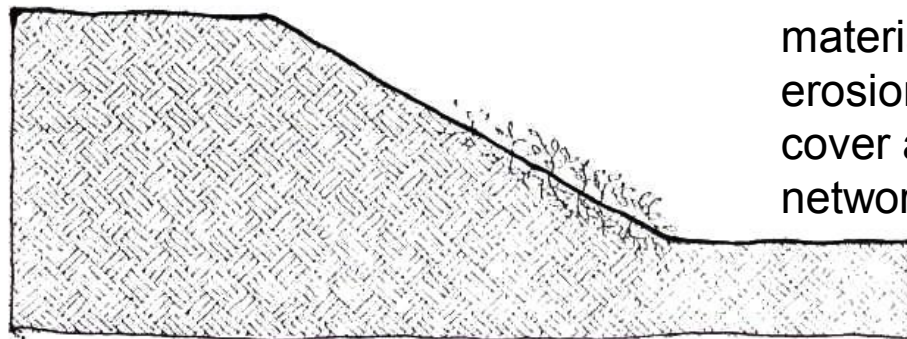
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1.11 SLOPE PROTECTION AND RETAINING STRUCTURES



1. The need for stabilizing a sloping ground can be reduced by diverting the runoff at the top of the slope or by **creating a series of terraces** to reduce the velocity of the runoff.

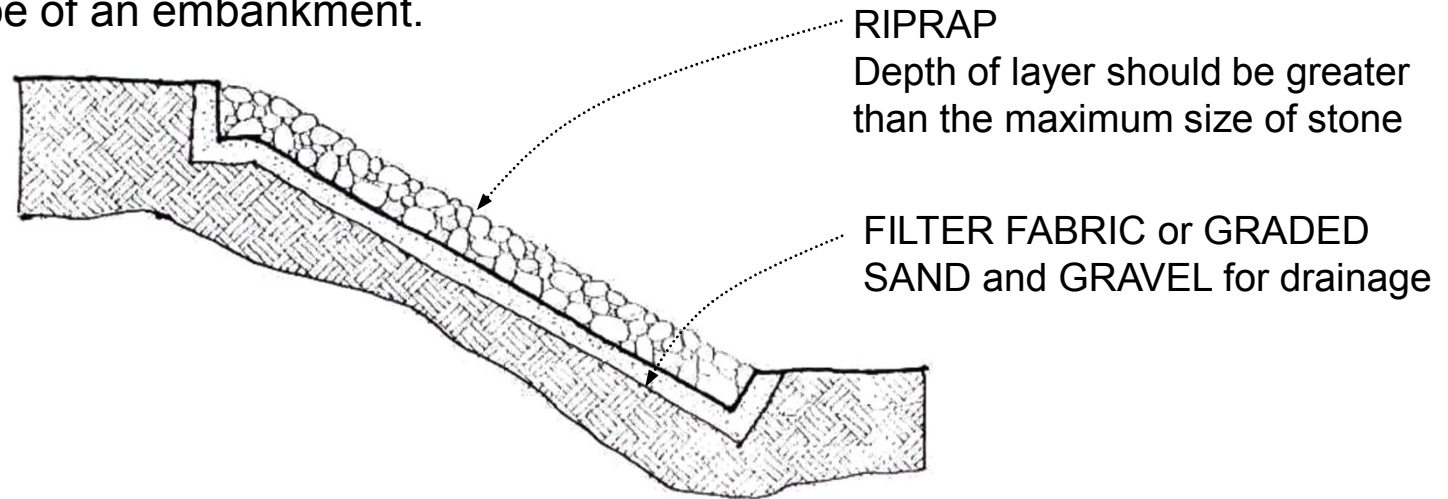


2. Natural means of stabilization include **soil binders** --- plant materials that inhibit or prevent erosion by providing a ground cover and forming a dense network of roots that bind the soil.

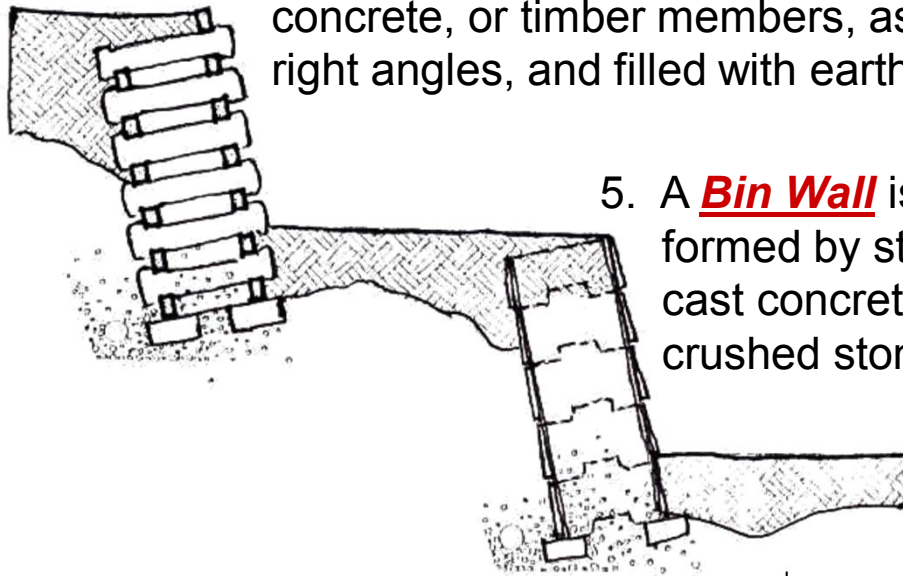
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3. **Riprap** is a layer of irregularly broken and random-sized stones placed on the slope of an embankment.



4. **Cribbing** is a cellular framework of squared steel, concrete, or timber members, assembled in layers at right angles, and filled with earth or stones.

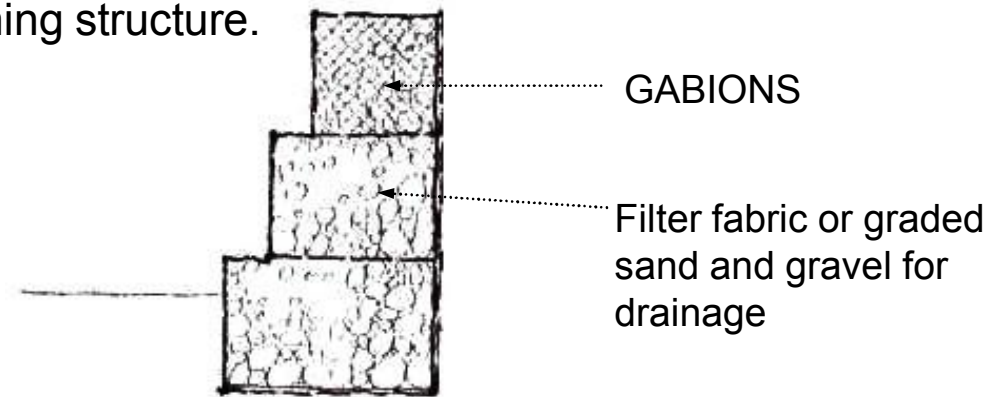


5. A **Bin Wall** is a type of gravity retaining wall formed by stacking modular, interlocking pre-cast concrete units and filling the voids with crushed stone or gravel.

Preparation for Construction

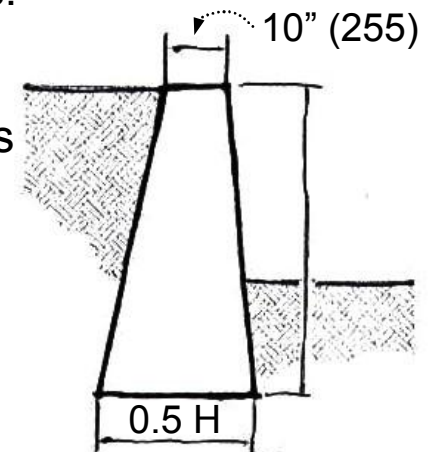
Staking-Out the Building
Laying the Batterboards
Formwork & Shoring
Construction Tools & Equipment
Major Parts of a Building
Foundation Bed
Site Investigation
Soil mechanics
Excavation & Earthworking
Site Drainage
Slope Protection and Retaining Structures
Pavements

6. **Gabions** are galvanized or PVC coated wire baskets filled with stones and stacked to form an abutment or retaining structure.



7. **Retaining Structures**. When a desired change in ground elevation exceeds the angle of repose of the soil, a retaining wall becomes necessary to hold the mass of earth on the uphill side of the grade change. The types of RC retaining walls are as follows:

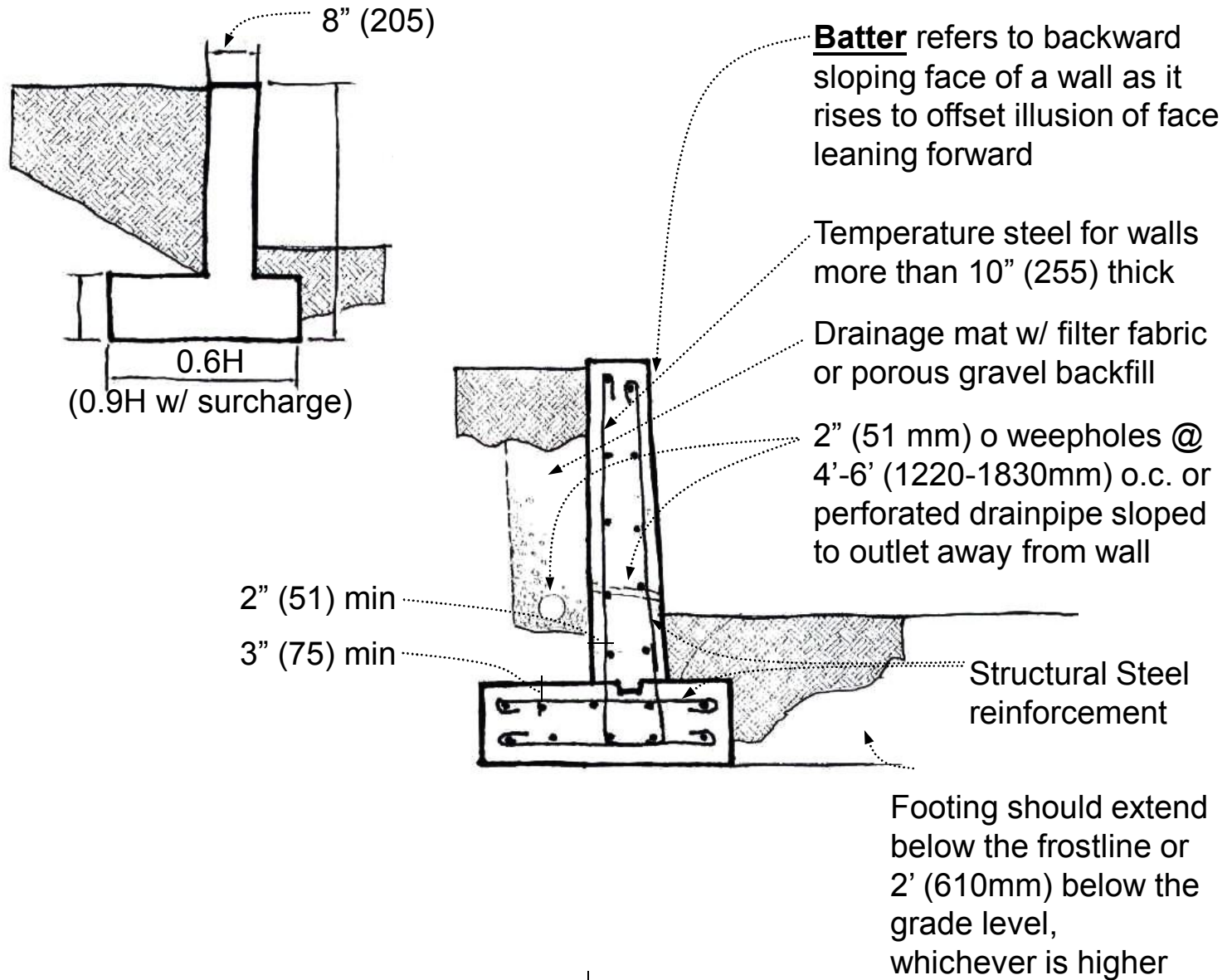
- a) **Gravity Retaining Wall** - resists overturning and sliding by the sheer weight and volume of its mass.



Preparation for Construction

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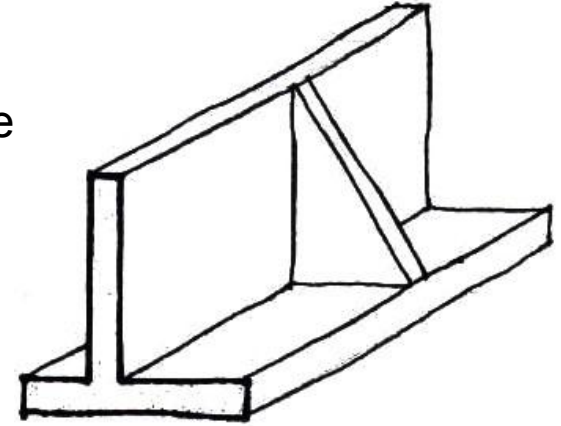
- b) **T-type Cantilevered Retaining Wall** – limited to a height of 20' (6 M); beyond this height a counterfort wall is employed.



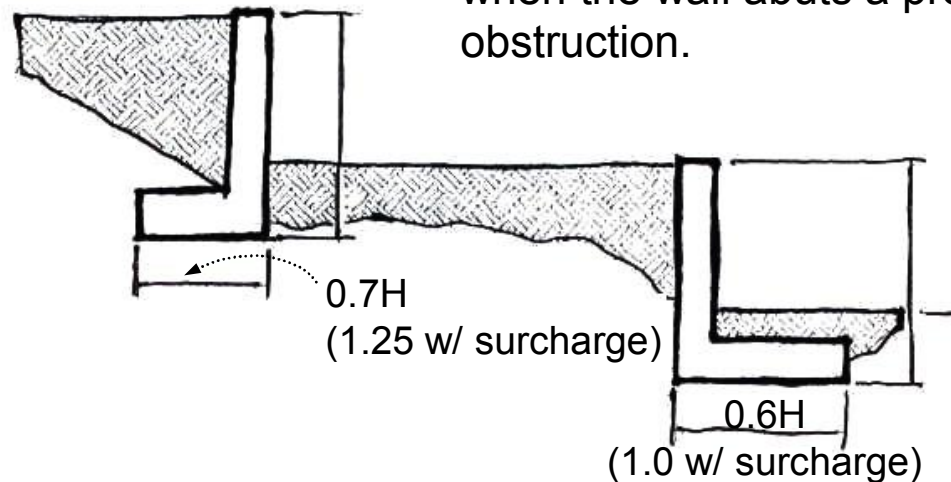
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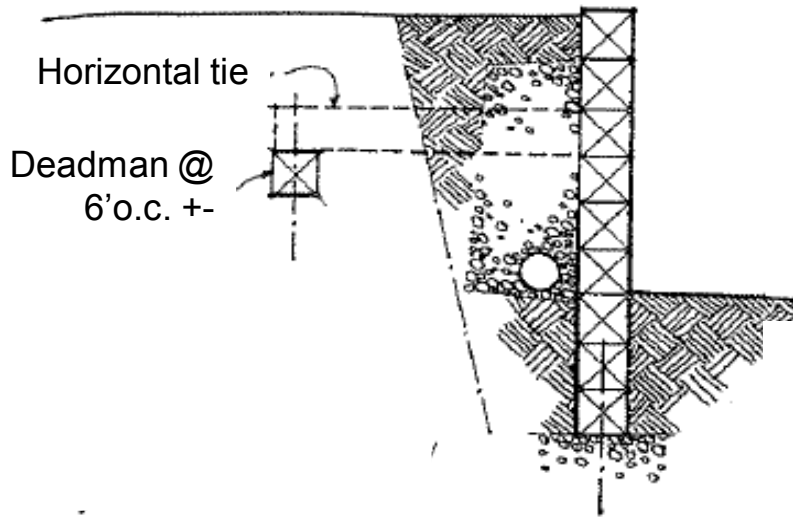
c) **Counterfort Retaining Wall**– utilizes triangular-shaped cross walls to stiffen the vertical slab and add weight to the base. The counterforts are spaced at equal intervals equal to one-half the wall height.



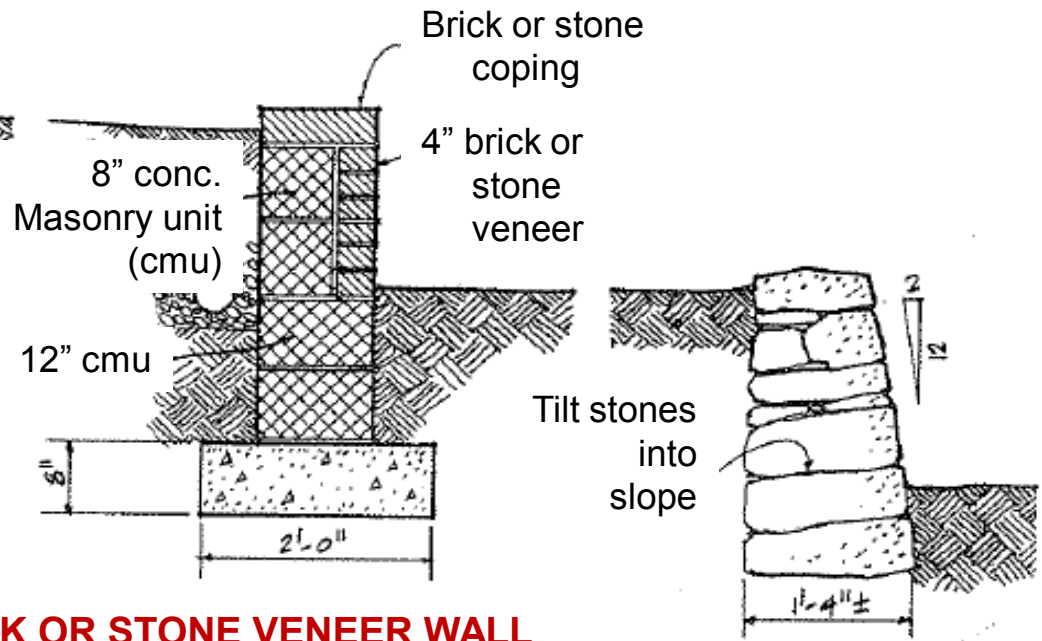
d) **L-type Cantilevered Retaining Wall** – used when the wall abuts a property line or other obstruction.



RETAINING WALL MATERIALS



HORIZONTAL TIMBER WALL

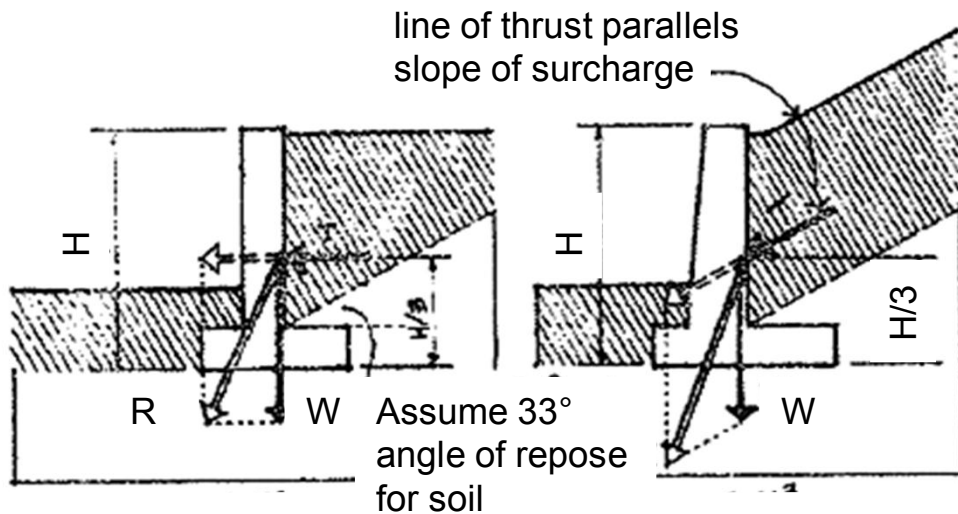


BRICK OR STONE VENEER WALL

Base need not extend to frost line – provide a well-drainage, compacted granular sub base.

DRY STONE WALL

STRUCTURAL CONSIDERATION: RETAINING WALLS

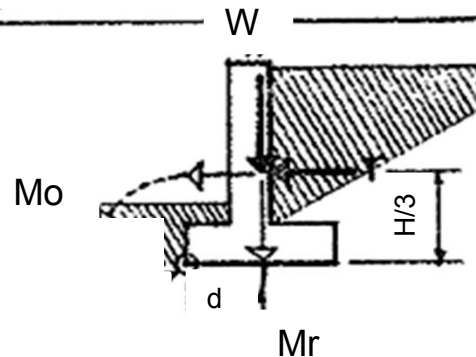


S = weight of soil

W = composite weight of wall acting through centroid of section

R = resultant of T and W

1. OVERTURNING

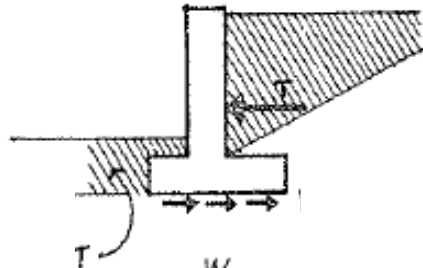


Retaining walls are used to create relatively level areas and to allow changes in elevation which cannot be accomplished by grading within the horizontal dimensions of a site. They must be constructed to resist the thrust of the soil being retained. This thrust can cause a retaining wall to fail in three ways.

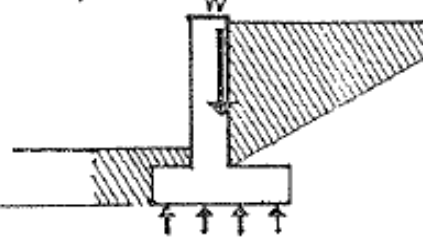
1. Overturning: The overturning moment of the soil thrust must be countered by the resisting moment of the composite weight of the wall and any soil bearing on the base.
2. Sliding: The lateral thrust on the wall must be resisted by the composite weight of the wall times the coefficient of friction for the soil supporting the wall.
3. Settling: The bearing capacity of the soil must not be exceeded by the vertical force.

STRUCTURAL CONSIDERATION: RETAINING WALLS

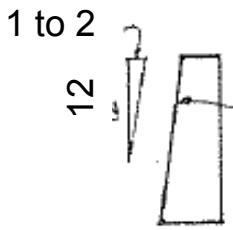
2. SLIDING
Soil in front of wall aids in resisting lateral force T



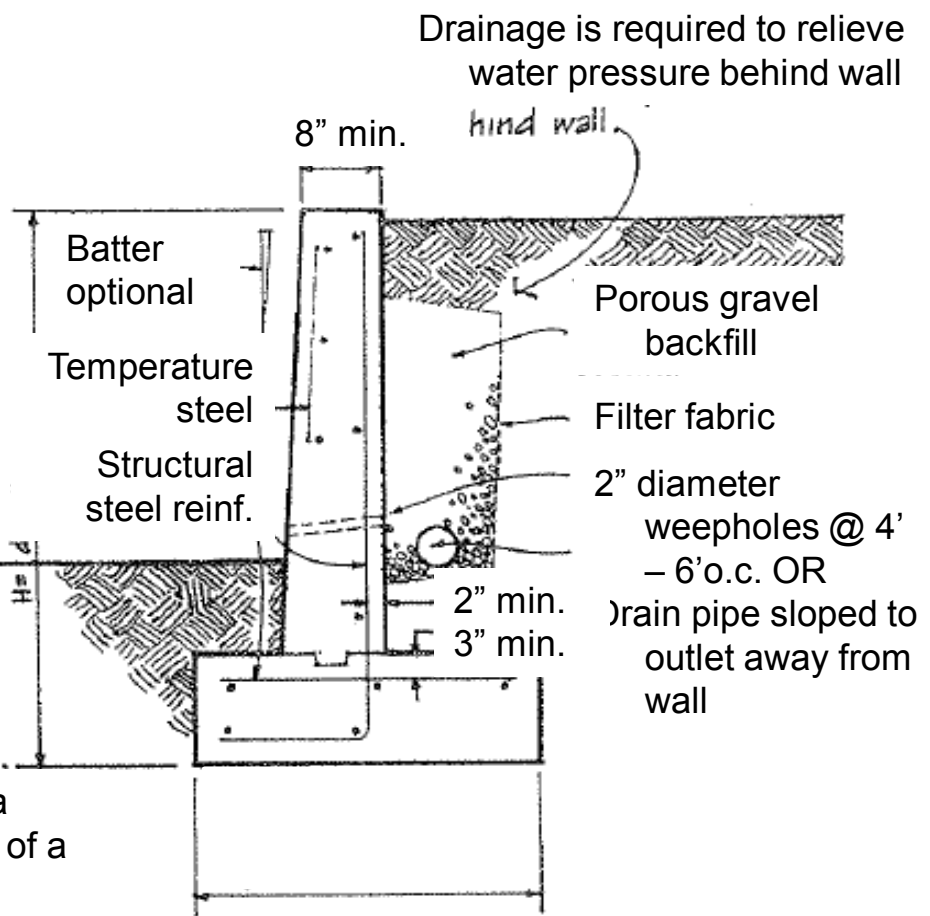
3. SETTLING



Footing should extend 2' below the lower grade



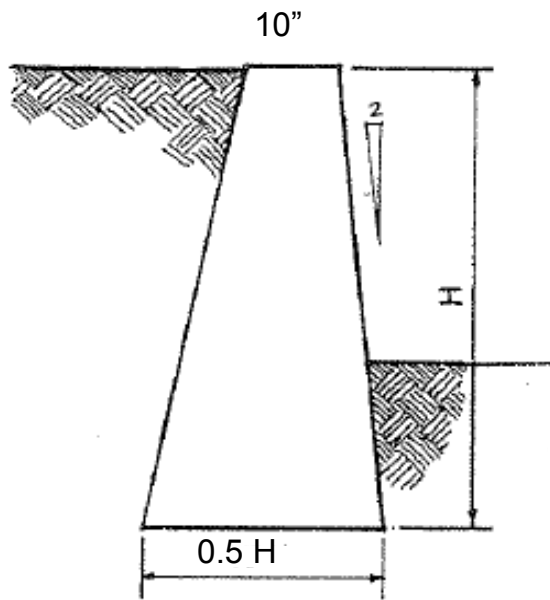
Batter refer to the sloping face of a wall which an offset the illusion of a vertical face leaning forward



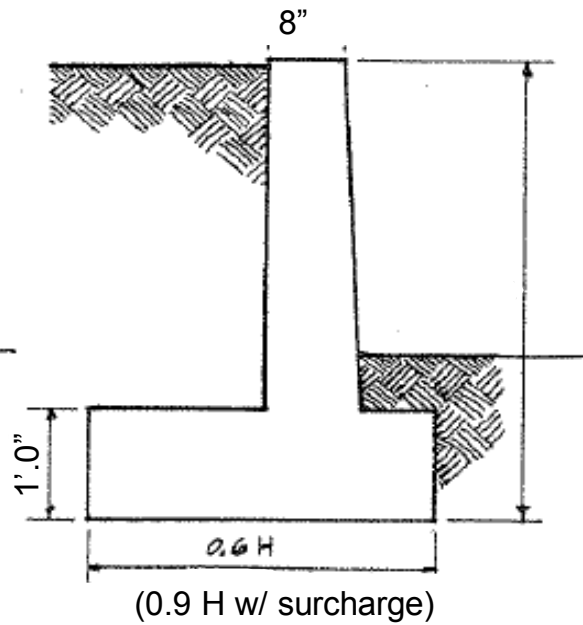
Drainage is required to relieve water pressure behind wall

REINFORCED CONCRETE RETAINING WALL

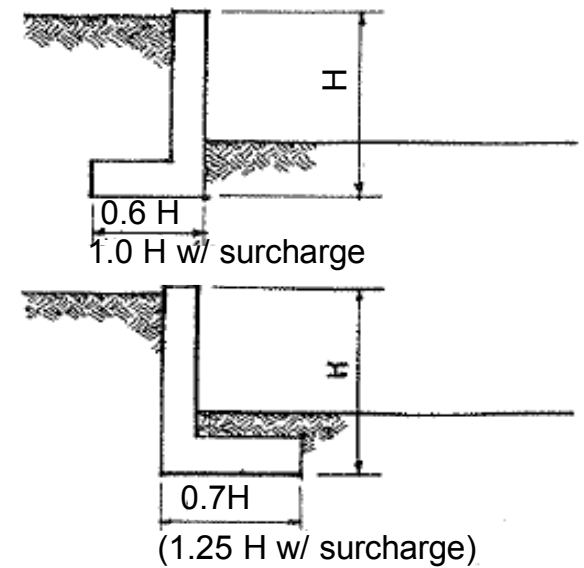
STRUCTURAL CONSIDERATION: RETAINING WALLS



GRAVITY WALL



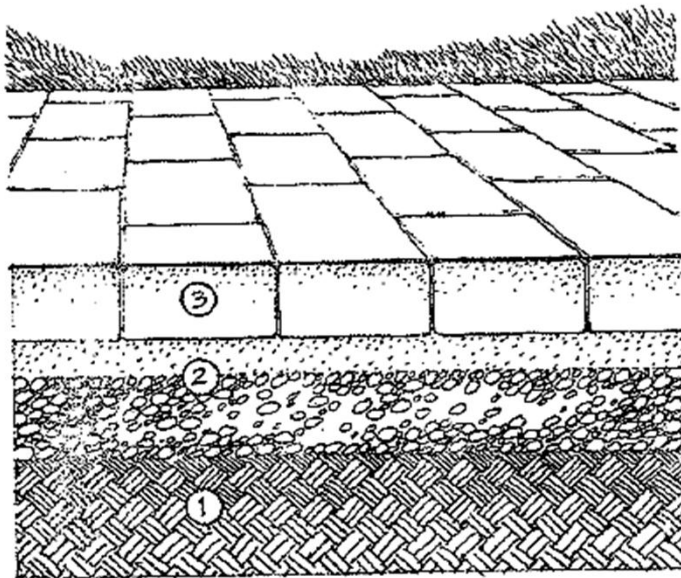
T-TYPE CANTILEVERED



L-TYPE WALL

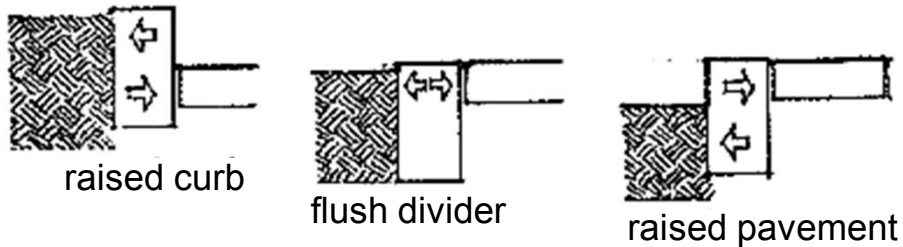
PAVEMENTS

Paving provides a wearing surface for pedestrian or vehicular traffic on a site.



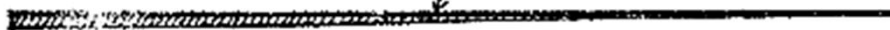
1. **The Subgrade** – which must ultimately carry the pavement load, should be undisturbed soil or compacted fill.
2. **The base** – is a foundation of well-graded aggregate that transfers the pavement load to the subgrade. It also prevents the upward migration of capillary water.
3. **The pavement**– receives the traffic wear, protects the base, and transfers its load to the base structure. There are two types of pavement: flexible and rigid. Flexible pavements, such as bituminous concrete or unit pavers on a sand setting bed. Rigid pavements, such as reinforced concrete slabs or paving units mortared over a broad area.

PAVEMENTS



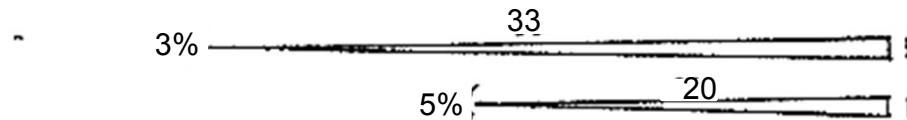
EDGE CONDITIONS

Slope for drainage



0.3% min.; 1% preferred;

highly textured pavements may require a steeper (2%) slope for drainage.



Slopes: 0% - 3% preferred; 5% maximum



Ramps: 5% - 8% ; use only where climatic conditions permit

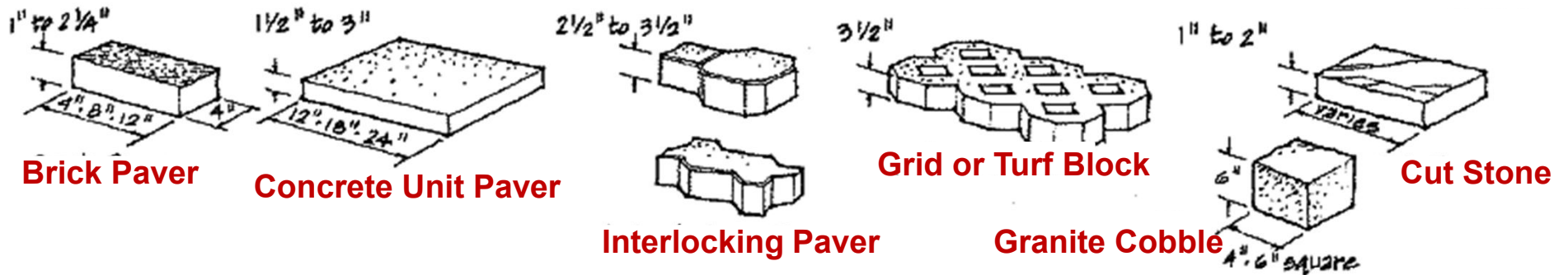
Flexible pavements require wood, steel, stone, masonry, or concrete edging to restrain the horizontal movement of the paving material.

Rigid pavements require reinforcement and an extension of the base material along their edges.

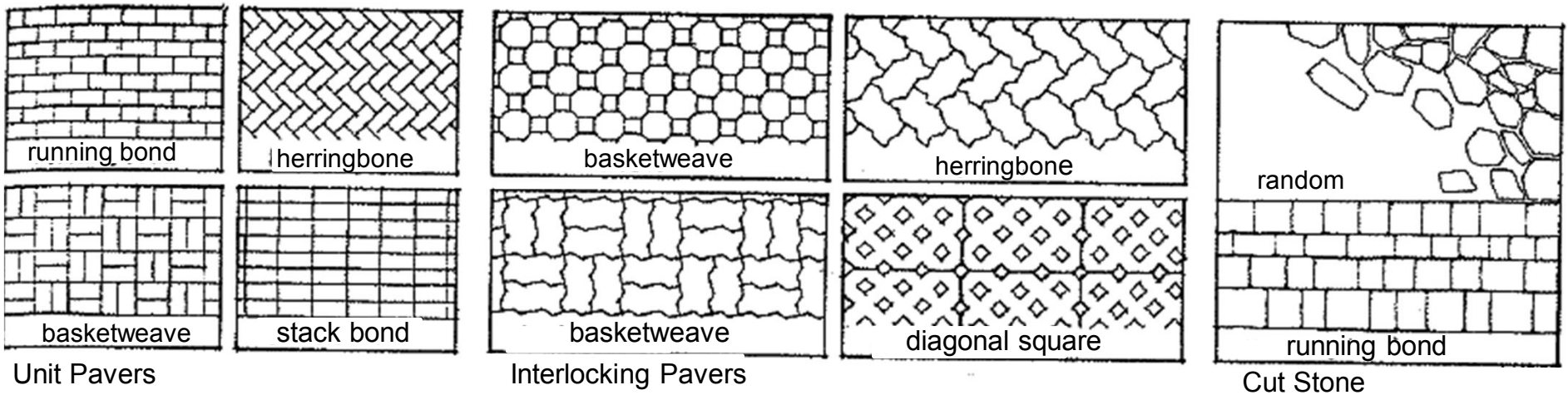
Additional notes:

- Pavement color and texture are important aesthetic considerations which also affect the pavement's absorption or reflection of heat and light.
- Avoid surface irregularities for wheelchair traffic.
- Provide tactile warning strips for the visually impaired at grade changes and hazardous vehicular area.

UNIT PAVING DETAILS



PAVING MATERIALS: Consult local supplier for availability of shapes, sizes, colors, textures, absorption properties, compressive strength, and installation recommendations.



PAVING PATTERNS

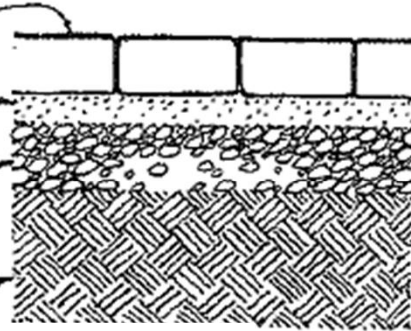
PAVING DETAILS

brick or conc. Pavers w/ handtight
Or 1/8"-1/4" sand swept joints

1"-2" sand setting bed

2"-6" compacted aggregate
where required in high traffic
wrears or over expansive soil

compacted subgrade or
undisturbed soil



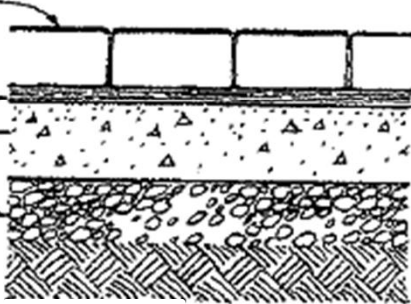
FLEXIBLE BASE

unit pavers as above

3/4" bituminous setting bed

4"-6" conc. slab

compacted aggregate, if req'd.



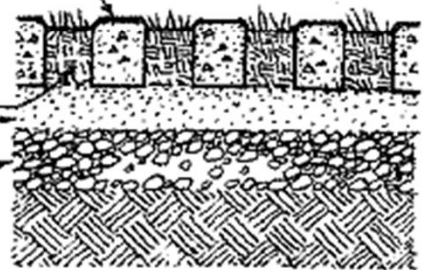
RIGID BASE

turf block

topsoil mix for grass or ground cover

2" sand setting bed

2"-6" compacted aggregate

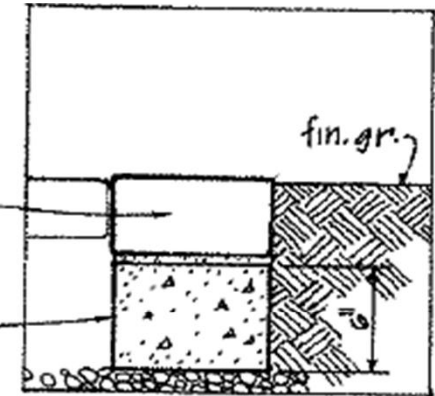


TURP BASE

EDGE CONDITIONS

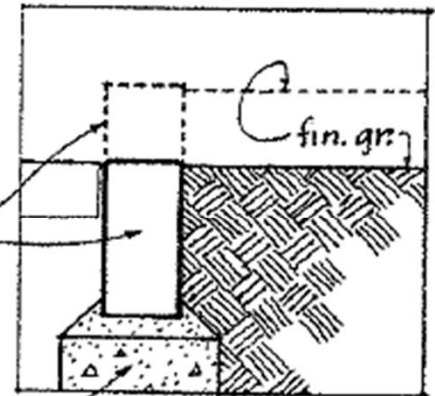
paving unit on mortar
bed, set on edge or
laid flat

conc. Grade beam
w/ exp. jts.



paving unit set
vertically on mortar
bed – may extend up
to 1/2 of paver ht. to
form curb

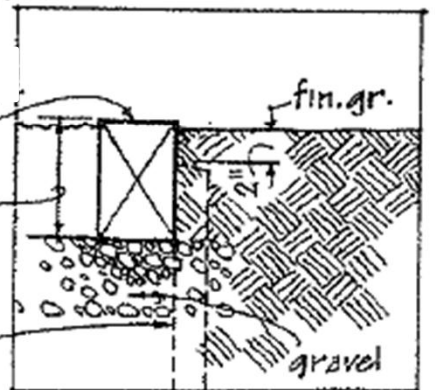
conc. or mortar ft'g.
(provide gravel under
footing if frost depth
is deeper than footing)



2x, 4x, or 6x pressure
treated wood edge

depth varies w/
paving material

2x2 or 2x4 p.t.
wood stakes, 24" long,
@ 3'-4' o.c.





END

THANK YOU