FOUNDATION STRUCTURE c2

c2.1 STRUCTURE - GRAVITY LOADS + CONCRETE
c2.2 STRUCTURE - SOIL PRESSURE ON FOUNDATIONS
c2.3 SOIL- TYPES, IDENTIFICATIONS
c2.4 SOIL- BEARING
c2.5 SOIL- CAUTIONS, FILL, COMPACTION
c2.6 GRAVEL- FUNCTIONS, SIZES, SHAPES
c2.7 FOOTINGS- CONTINUOUS 1
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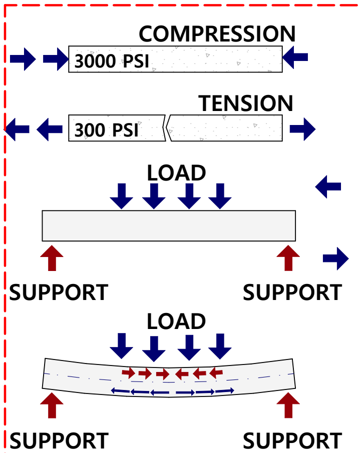
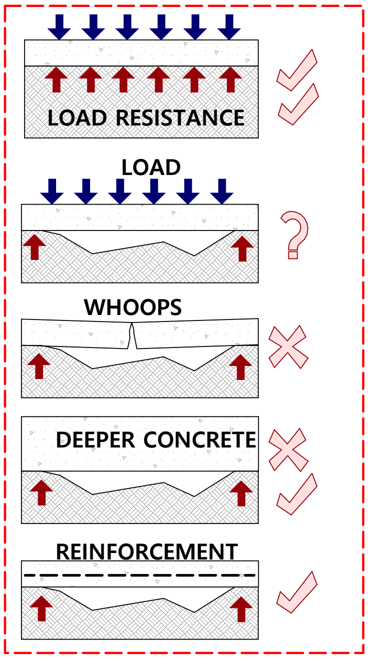
c2.20 STEP FOOTING GENERAL RULES





PRECAST CONC BEAM

SOG WITH INTEGRAL FOOTING

REINFORCED FOOTING

2 WAY STRUCTURAL SLAB

A GENERAL CONCRETE (AND MASONRY) PERFORMANCE RULE

***COMMON CHARACTERISTICS_**MASONRY PRODUCTS INCLUDING CONCRETE, CONCRETE BLOCK, MORTAR, AND PARGES ARE SOME MIXTURE OF A GRAVEL, & OR SAND, WATER AND A BINDING AGENT (PORTLAND CEMENT). THEY ARE MIXED, PLACED, AND THEY HARDEN INTO A SOLID MATERIAL. AS A MATERIAL GROUP THEY ARE MUCH STRONGER IN COMPRESSION AND GENERALLY WEAK IN TENSION. MOST FOUNDATION SYSTEMS USE MASONRY PRODUCTS. IN A LOT OF CONDITIONS THEIR COMPRESSIVE STRENGTH IS ALL THAT IS CALLED FOR, AND THEY DO FINE IN THEIR UNADULTERATED STATE. IN OTHER CONDITIONS TENSILE STRENGTH IS CALLED FOR, AND THESE PRODUCTS NEED SOME 'REINFORCEMENT' HELP. BECAUSE THIS COMES UP SO FREQUENTLY IT IS WORTH UNDERSTANDING THE WHY AS IT GIVES EXPLANATION TO A LOT OF VERY TYPICAL CONSTRUCTION DETAILS AND TECHNIQUES. THIS EXPLANATION WILL RESTRICT ITSELF TO CONCRETE BUT THE PRICIPLES HOLD FOR ANY OF THE MASORY PRODUCTS.

COMPRESSIVE STRENGTH

***WHAT IS IT_**COMPRESSIVE STRENGTH IS A RESISTANCE MEASUREMENT FOR A MATERIAL BEING COMPRESSED OR PUSHED. WHEN SOMETHING IS PUSHED ON HARD ENOUGH IT WILL COLLAPSE OR CRUMBLE.

***RATING_** COMPRESSIVE STRENGTH FOR CONCRETE MIXES ARE RATED IN POUNDS PER SQUARE INCH. THE COMMOM RATINGS FOR **MOST** CONSTRUCTION CONCRETES ARE FROM 2500 PSI TO 5000 PSI.

***CODE REQUIREMENTS_**MINIMUM STRENGTHS FOR WEATHER PROTECTED FOOTINGS, WALLS AND SLABS MAY BE 2500 PSI, AND WEATHER EXPOSED WALLS AND SLABS MAY BE 3,000 PSI. STRONGER CONCRETES MAY BE SITUATION SPECIFIC. THE VARIOUS STRENGTHS ARE A FUNCTION OF THE MIX.

***THE VEHICLE EXAMPLE_**CONSIDER A HEAVY 5,000 LB SUV VEHICLE SITTING ON A GARAGE SLAB. THE LOAD DISTRIBUTED TO EACH TIRE IS 1250 LBS SPREAD OVER (SAY) 30 SQ INCHES OF TIRE MEETING THE SLAB. THE LOAD ON THE CONCRETE THEN IS 42 PSI. THE CONCRETE CAN HANDLE 3000 PSI.

***BUT_**THAT MORE THAN STRONG ENOUGH CONCRETE IS SITTING ON SOIL. HOW STRONG IS THE SOIL?

TENSILE STRENGTH

***WHAT IS IT_**THE TENSILE STRENGTH IS THE RESISTANCE MEASUREMENT OF A MATERIAL BEING PULLED. A SIMPLE MENTAL IMAGE IS A WEIGHT IS TIED TO THE BOTTOM OF A STRING. THE STRING IS IN TENSION-IT IS BEING PULLED. IF PULLED HARD ENOUGH THE STRING WILL BREAK. WHEN IT BREAKS THE TENSILE STRENGTH OF THE STRING HAS BEEN EXCEEDED.

***CONCRETE TENSILE STRENGTH_**CONCRETE, AS A RULE OF THUMB , HAS A TENSILE STRENGTH OF ABOUT 10% OF ITS COMPRESSIVE STRENGTH. SO A 3000 PSI CONCRETE WILL HAVE A TENSILE STRENGTH OF 300 PSI. IT IS CONCRETE'S WEAKNESS- OR LIMITATION.

***STEEL TENSILE STENGTH_**A GRADE 40 STEEL REINFORCING BAR HAS A TENSILE STRENGTH OF 40,000 PSI. INTRODUCING THIS NUMBER IS SORT OF OUT OF SEQUENCE, BUT WILL MAKE SENSE WHEN THE IDEA OF REINFORCING CONCRETE IS NOTED BELOW

THE BEAM IDEA

***A BEAM_**BEAMS ARE ALWAYS THOUGHT OF AS SPANNING ENTITIES RUNNING FROM SUPPORT POINT TO SUPPORT POINT, SUCH AS A JOIST OR BEAM. THE ILLUSTRATION OF THE SIMPLE BEAM ABOVE IS UBIQUITOUS SHOWING THE TOP HALF OF THE BEAM ITSELF BEING IN COMPRESSION (PUSHING IN) AND THE BOTTOM HALF OF THE BEAM IN TENSION (PULLING OUT). BEND A PENCIL SLOWLY UNTIL IT BREAKS AND THE IDEA IS ILLUSTRATED.

***BEHAVING LIKE A BEAM_**ABSTRACTLY ANYTHING THAT IS BEING SUPPORTED SPORADICALLY IS BEHAVING LIKE A BEAM (OR MANY BEAMS). SOMETHING BEING SUPPORTED CONTINUOUSLY AND ABSOLUTELY CONSISTENTLY HAS NO REASON TO BEHAVE LIKE A BEAM. THAT ENTITY WOULD BE FULLY SUPPORTED AND (ESSENTIALLY) IN COMPRESSION ONLY.

***THE APPLICATION OF THE IDEA_**FOOTINGS AND SLABS LAY ON THE GROUND. IF THAT GROUND OFFERS ABSOLUTELY CONSISTENT SUPPORT THEN THE CONCRETE SITTING ON IT IS BEHAVING IN COMPRESSION ONLY WHICH IS WHERE IT SHINES. IF THE GROUND IN NOT CONSISTENT THEN THE CONCRETE IS FORCED TO BEHAVE LIKE A WHOLE BUNCH OF BEAMS SPANNING FROM STRONGER SOIL TO STRONGER SOIL (SUPPORT TO SUPPORT). BOTTOM LINE IS THAT UNIFORM SOIL SUPPORT UNDER CONCRETE FOOTINGS AND SLABS IS SMART.

HOW TO GET CONCRETE TO PERFORM LKE A BEAM

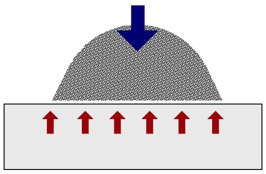
***MORE OR STRONGER CONCRETE?_**SO WHEN A SOIL IS INCONSISTENT THE FOOTING OR SLAB IS BEING ASKED TO PERFORM LIKE A BEAM. WHEN THIS GREATER TENSILE STRENGTH IS CALLED FOR IT IS ALWAYS POSSIBLE TO USE A STRONGER CONCRETE AND OR TO USE MORE CONCRETE. MAKE THE FOOTING DEEPER AND WIDER, THICKEN THE SLAB OR WALL. THERE IS A PRACTICAL POINT WHERE MORE CONCRETE IS MORE COSTLY AND OR LESS EFFECTIVE THAN USING REINFORCING STEEL.

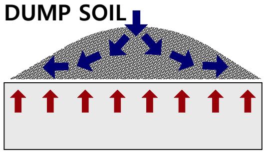
***REINFORCEMENT IDEA_** THE STEEL REINFORCEMENT IDEA (40,000 PSI !) EMBEDS STEEL (REINFORCING BARS) IN THE CONCRETE WHERE THE STRUCTURE DEMANDS TENSILE STRENGTH. CONCRETE IS TRANSFORMED INTO BEING VERY CAPABLE IN TENSION AND PERFORMING VERY SUCCESSFULLY AS A 'BEAM'. THE PRECAST CONCRETE BEAM ILLUSTRATED IS AN EXAMPLE OF JUST THAT. NOTE THE LOCATION OF THE REINFORCING BEING CLOSER TO THE BOTTOM OF THE BEAM WHERE THE TENSION IS THE GREATEST.

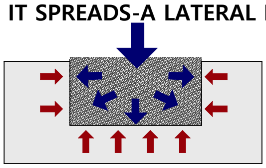
***REINFORCEMENT BARS_**ARE A ROUGH TEXTURED STEEL BAR USUALLY 1/2"(#4), OR 5/8"(#5) OR 3/4"(#6) IN DIAMETER. THEIR PLACEMENT IS REQUIRED BEFORE THE CONCRETE POUR. THE PLACEMENT IS EXTREMELY IMPORTANT OR THE INTENDED STRUCTURAL JOB WILL NOT BE ACCOMPLISHED.

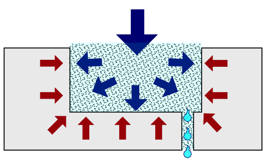
***PLACEMENTS_**AS THE VARIOUS FOUNDATION COMPONENTS ARE DETAILED THE APPROPRIATE REINFORCEMNT PLACEMENT WILL BE DISCUSSED.

STRUCTURAL PRINCIPLES- SOIL PRESSURE ON FOUNDATION WALLS

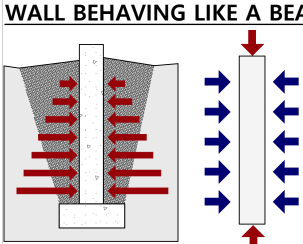

DUMP SOIL

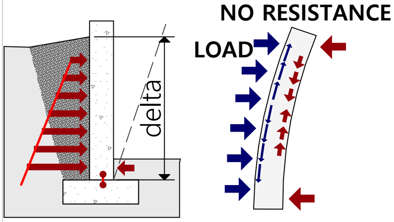

IT SPREADS-A LATERAL LOAD


A CONSTRAINED CONDITION-

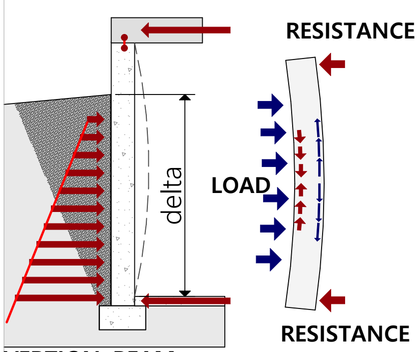

RELIEVE THE WATER (PRESSURE)-

WALL BEHAVING LIKE A BEAM

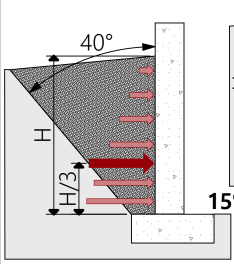

NEUTRAL BEAM LOAD



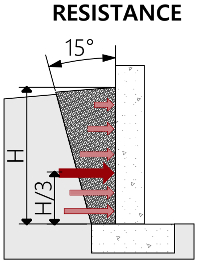
CANTILEVER BEAM RESISTANCE



VERTICAL BEAM



40° ANGLE OF REPOSE



15° ANGLE OF REPOSE

BASICS OF SOIL PRESSURE

***DUMPING 'PARTICLES' AND WATER_**THIS ABSTRACTION MIMICKS FOUNDATION BACKFILLING AND MAY HELP VISUAIZE THIS SOIL PRESSURE CONDITION.

***UNCONSTRAINED CONDITION_**DUMPING ANY VOLUME OF GRAVEL OR SOIL (PARTICLES) ONTO A FLAT SURFACE WILL RESULT IN SOME DEGREE OF SPREAD. PARTICLE SIZE AND GEOMETRY (ROUND/ANGULAR) WILL RESULT IN DIFFERENT DEGREES OF SPREAD. WATER WILL SPREAD INFINITELY

***CONSTRAINED CONDITION_**DUMPING THE SAME MATERIAL INTO A CONTAINER WILL ELIMATE THE PHYSICAL SPREAD- BECAUSE THE CONTAINER IS RESISTING IT. THAT RESISTANCE NEEDS TO EQUAL THE LOAD OR THE CONTAINER WILL BREAK.

***THE LOAD_**THAT PRESSURE IS A FUNCTION OF THE WEIGHT OF THE SOIL (+/- 100 # PER CUBIC FT) AND THE WEIGHT OF HOWEVER MUCH WATER IT IS HOLDING (62 # PER CU FT). THE AMOUNT OF WATER THE SOIL MAY HOLD IS DEPENDENT ON THE VOLUME OF THE MANY VOIDS BETWEEN THE SOIL PARTICLES. THE VOLUME AND WEIGHT INCREASE WITH DEPTH. THE LOAD THEN INCREASES WITH INCREASED DEPTH.

***THE WATER_**WATER IS THE GREAT VARIABLE IN THIS LOADING. THIS CONTAINER WOULD REMAIN AT FULL (SOIL AND WATER) LOAD -WHICH IS NEVER DESIRABLE- UNLESS A DRAIN LINE IS AVAILABLE TO RELIEVE THE WATER WEIGHT & PRESENCE. THINK FOUNDATION DRAIN.

THE BEAM IDEA-VERTICALY

***GRAVITY LOADS_** GRAVITY LOADING IS A PRIMARY LOADING THAT **USUALLY** COMES TO MIND FIRST. THE SECOND GROUP OF LOADS THAT **NEED** TO COME TO MIND ARE THE LATERAL LOADS.

***LATERAL LOADS_**SOIL PRESSURE AND WIND ARE THE 2 MAJOR SOURCES OF LATERAL LOADS. SOIL EXERTS PRESSURE ON A WALL WHEN RESTING AGAINST IT. WIND (PRESSURE) PUSHES AND OR PULLS ON A WALL WHEN IT IS ACTIVE, BUT HAS MODEST IMPACT ON FOUNDATION WALLS, AND THERFORE NOT A CONDITION DISCUSSED THIS CHAPTER.

***BEHAVING LIKE A BEAM_**LATERAL LOADING ASKS WALLS TO PERFORM LIKE (VERTICAL) BEAMS. SOIL PRESSURE IS THE PRIME FORCE.

***SOIL LOADING_**THE WEIGHT OF SOIL PRESENTS A DOWNWARD (GRAVITY) LOAD, AND A HORIZONTAL (LATERAL) LOAD. THE HORIZONTAL COMPONENT OF THIS LOADING BECOMES A PRIME BASIS FOR FOUNDATION WALL DESIGN. QUANTIFYING THE SOIL LOAD BECOMES NECESSARY.

EQUAL LATERAL LOADS

***EQUAL BACKFILL-EQUAL LOAD_**THIS GRAPHIC SHOULD SAY IT ALL. IF THE PRESSURE IS EQUAL ON BOTH SIDES, THAT LATERAL LOADING IS NEUTRALIZED. THE ONLY CONCERN IN THIS INSTANCE THE GRAVITY LOAD AND THEREFORE THE FOOTING DESIGN IS IN PLAY

UNEQUAL LATERAL LOADS

***UNEQUAL LOAD ARE THE CONCERN_**THE DIMENSIONAL DESIGNATION **delta** IS THE HEIGHT DIFFERENTIAL OF THE SOIL (PRESSURE) ON EACH SIDE OF THE WALL. **DIFFERENTIAL** OR **UNBALANCED** FILL ARE THE COMMON TERMS USED IN QUANTIFYING THIS TYPICAL CONSTRUCTION CONDITION. FOUNDATION WALLS ARE FAR MORE CHALLENGED BY THIS CONDITION OF DIFFERENTIAL OR UNBALANCED FILL THAN BY GRAVITY LOADS. IT IS THIS LATERAL PRESSURE THAT WALLS NEED TO BE DESIGNED AROUND.

WALL RESTRAINED AT BOTTOM ONLY- THE CANTILEVER WALL

***FIXED AT THE BOTTOM ONLY_**THE WALL CONDITION IS FIXED AT THE BOTTOM AND 'FREE' AT THE TOP. THE 'FIXING' AT THE BOTTOM IN THIS CONDITION CAN BE A BIG DEAL. THE SOIL WANT TO PUSH THE WALL, SO RESISTANCE TO 'SLIDING' IS REQUIRED. THE SOIL ALSO WANTS TO TIP OVER THE WALL SO RESISTANCE TO 'OVERTURNING ' IS ALSO WANTED.

***SLIDING_** TIEING FOOTING TO WALL MANAGES THE SLIDING POTENTIAL.

***OVERTURNING_**INTEGRATING FOOTING AND WALL REINFORCEMENT SO THEY ACT AS ONE ENTITY, WHILE SPREADING THE FOOTING OUT, ARE DESIGN METHODS TO HELP RESIST OVERTURNING.

FULL BASEMENT VERTICAL BEAM WALL

***FIXED AT THE BOTTOM** _A CONCRETE FLOOR SLAB (IF POURED UP TO THE WALL) PREVENTS THE WALL FROM MOVING INWARD (SLIDING). THIS WALL MIGHT ALSO BE "FIXED' TO THE FOOTING.

***FIXED AT THE TOP_** A WALL PLATE IS ANCHORED INTO THE TOP OF THE WALL, AND THE ENTIRE FLOOR FRAMING PACKAGE (A DIAPHRAM) IS TIED TO THE PLATE. IT OFFERS A BIG RESISTANCE AGAINT BEING PUSHED.

***THE SPAN INBETWEEN_**SO THE WALL IS FIXED TOP AND BOTTOM. THE 'SPAN' IS THE HEIGHT OF THE WALL FROM SLAB TO ANCHOR.

***THE WALL IS THE BEAM_**SOIL PRESSURE WILL PUSH IN. THE SAME PRINCIPLES OF COMPRESSION AND TENSION ARE IN PLAY AS DISCUSSED. THE SOIL SIDE OF THE WALL IS IN COMPRESSION. THE OPPOSITE SIDE OF THE WALL IS IN TENSION.

***THE WALL DESIGN_**THE ABILITY TO HANDLE THESE LOADS IS INCREASED WITH THICKER MASONRY WALLS, AND IS INCREASED FURTHER WITH REINFORCED MASONRY (AND CONCRETE) WALLS.

QUANTIFYING LATERAL LOADS

***SOIL VOLUME_**THEORETICLLY THE 'SELF SUPPORTING' EARTH-AFTER EXCAVATION-POSES NO PRESSURE THREAT. THE BACK FILL DOES. UNDERSTANDING THE CONSTRUCTION CUT AND BACKFILL VOLUME DIRECT ONE TOWARD AN ACTUAL LOAD.

SOILS & FOUNDATIONS

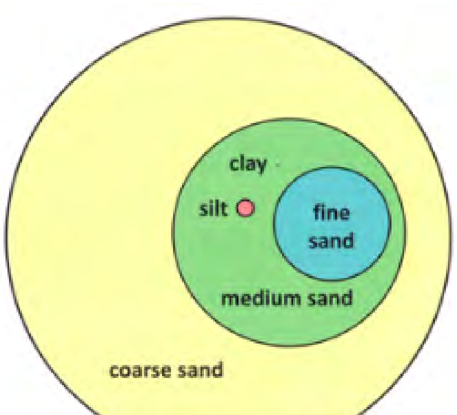
***CRITERION**_THE ESSENTIAL PURPOSE OF SOIL IN CONSTRUCTION IS TO PROVIDE A STABLE (OR AT LEAST PREDICTABLE) PLATFORM TO BUILD ON AND IN.
***BEARING**_BUILDING LOADS ULTIMATELY GET RESOLVED THROUGH FOUNDATION CONSTRUCTION TO THE FOOTINGS THAT SIT DIRECTLY ON THE EARTH. THE EARTH NEEDS TO BE FIRM ENOUGH TO PREVENT THE BUILDING FROM SINKING.
***BEARING & SETTLEMENT**_BUILDING MAY (DO) SETTLE (JUST A LITTLE BIT) INTO THAT EARTH. ALL EARTH IS NOT SOLID AND ABSOLUTELY PERMANENT BEDROCK. THE THINKING IS TO DESIGN A STRUCTURE SO IT SETTLES UNIFORMLY/CONSISTENTLY, AND THAT THERE IS JUST A BIT OF FORGIVENESS IN THE TOTAL STRUCTURE SUCH THAT IT CAN 'ABSORB' A BIT OF MOVEMENT WITHOUT DAMAGE. LETS QUANTIFY THIS ACCEPTABLE SETTLEMENT IN FRACTIONS OF AN INCH.
***WATER CONTENT**_WATER IN THE SOIL IS THE 'LIVE' INGREDIENT. WATER HAS VOLUME. WHEN IT ENTERS SOIL THE SOIL EXPANDS. WHEN IT DRIES, THE SOIL SHRINKS. WATER IN THE SOIL CAN FREEZE AND EXPAND (YET AGIN) WHEN IT BECOMES ICE. AND SHRINK AGAIN WHEN IT THAWS. THE SOIL QUESTION THEN IS HOW WELL A SOIL DRAINS, OR DOESN'T DRAIN.
***WATER CONTENT & MOVEMENT**_THE SWELLING AND SHRINKIING OF SOIL AS A CONDITON OF THE QUANTITY OF WATER CONTENT CAN CAUSE THE SOIL UNDER FOOTINGS TO RISE AND DROP, AND CAN CAUSE INCREASED PRESSURE AGAINST FOUNDATION (BASEMENT) WALLS.
***WATER CONTENT & FROST**_ALL SOILS DO HAVE SOME MOISTURE CONTENT WHICH WILL FREEZE AND NECESSARILY EXPAND IN FREEZING TEMPERATURES. IN A WINTER CYCLE THAT EARTH FREEZES (DOWNWARD) INCH BY INCH UNTIL IT REACHES WHAT IS REGIONALLY CONSIDERED A FROST DEPTH-OR THE MAXIMUM DEPTH THAT FROST MAY ACHIEVE. THAT BECOMES THE MINIMUM DEPTH INTO THE EARTH OF SETTING SUPPORTING FOOTINGS. ALL EARTH ABOVE THAT FROST LINE WILL EXPAND AND PUSH CONSTRUCTIONS (FROST HEAVES). BETTER DRAINING SOILS (AND GRAVELS) WILL HOLD LESS WATER/MOISTURE, AND THERFORE HAVE A LOWER DEGREE OF EXPANSION, AND SUBSEQUENT CONTRACTION.
***BOTTOM LINE**_ THESE PRINCIPLES OF BEARING CAPACITY AND WATER CONTENT ARE PRETTY SIMPLE. QUANTIFYING BOTH IS THE BOTTOM LINE. SOIL TYPE(S) THAT A PROJECT IS TO BUILT ON SHOULD BE EXAMINED AT LEAST TO THE EXTENT THAT A CONFIDENT DESIGN TO INSURING ADEQUATE BEARING, AND MANAGING WATER CONTENT RELATED CONCERNS ARE ADDRESSED.
***SOIL SCIENCE**_THIS PRETTY STRAIGHT FORWARD CONDITION/CONCERN GETS REAL COMPLICATED AS ONE DIGS DOWN INTO THE GEOLOGICAL SCIENCE. IT IS WAY BEYOND THIS DISCUSSION TO DO ANYTHING BUT HIGHLIGHT SOME BASICS INTENDED TO KEEP THE DIY'ER OUT OF TROUBLE.

Table 1
Properties of Soils Classified According to the Unified Soil Classification System
Table reference: 2012 IRC Table R405.1

Soil Group	Unified Soil Classification System	Soil Description	Drainage Characteristics (a)	Frost Heave Potential	Volume Change Potential Expansion (b)	Presumptive Load-Bearing Pressure (PSF) (d)
Group I Excellent	GW	Well graded gravel, gravel-sand mixtures, little or no fines	Good	Low	Low	3000
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines	Good	Low	Low	3000
	SW	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low	2000
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low	2000
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low	2000
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low	2000
Group II Fair to Good	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low	2000
	SC	Clayey sands, sand-clay mixture	Medium	Medium	Low	2000
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	Low	1500(c)
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium	Medium	Medium to Low	1500(c)
Group III Poor (e)	CH	Inorganic clays of high plasticity, fat clays	Poor	Medium	High	1500(c)
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	High	High	1500(c)
Group IV Unsatisfactory (e)	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium	By Test
	OH	Organic clays of medium to high plasticity, organic silts	Unsatisfactory	Medium	High	By Test
	PT	Peat and other highly organic soils	Unsatisfactory	Medium	High	By Test

SOIL PROPERTIES

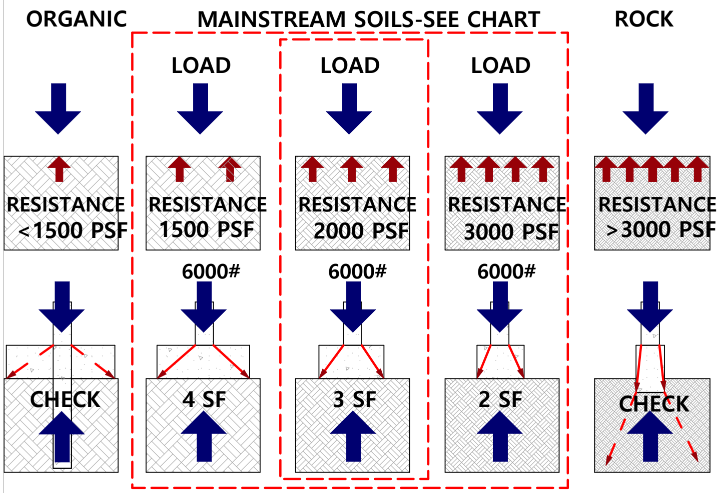
***THE CLASSIFICATIONS**_LOTS OF SOIL CHARTS OUT THERE. THIS DISCUSSION ELECTS TO USE THIS USCS CHART (THAT IS PART OF OUR BUILDING CODE) WHICH IS ABOUT AS SIMPLE AND COMPLETE AS ONE MIGHT FIND. IT NOTES BEARING CAPACITY AND WATER CONTENT CHARACTERISTICS BASED ON SOIL TYPE- WHICH ARE OUR CONCERNS.
***BREAKDOWN**_ THE SOIL DESCRIPTIONS SUGGESTS SOILS ARE MADE UP OF PARTICLE TYPES -GRAVELS, SANDS, SILTS, AND CLAY. NOT ALL, BUT MANY/MOST ARE NOT 'PURE' BUT SOME COMBINATION OF MORE THAN ONE PARTICLE TYPE- FOR EXAMPLE, TYPE SC (CLAYEY SANDS). EACH PARTICLE TYPE HAS A SIZE PARAMETER AND BEHAVIOR CHARACTERISTIC- SUMMARIZED BELOW.
***THE CLUE**_PRESUMPTIVE LOAD BEARING OF LESS THAN 2000 IS AN ALERT TO A SOIL MIX THAT ONE WANTS TO BE CAREFUL WITH. THERE ARE WAYS TO WORK WITH THESE MORE PLASTIC SOILS.

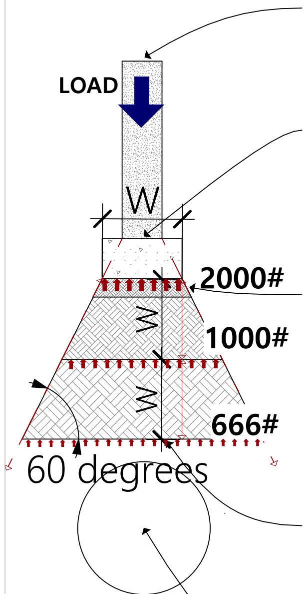


PARTICLES

***PARTICLE TYPES/SIZE**S_THIS SCALED DIAGRAM GRAPHICALLY DESCRIBES RELATIVE PARTICLE SIZE. THESE 'GRADES', FOR EXAMPLE, OF SANDS, HAVE SPECIFIED SIZE PARAMETERS. A MEDIUM SAND IS SO GRADED BECAUSE IT HAS A MAXIMUM & MINIMUM SIZE. THE TAKE AWAY IS THAT CLAY PARTICLES (A PENCIL DOT) ARE VERY VERY VERY FINE. A SILT PARTICLE, MUCH LARGER, IS NOT VISIBLE (DECERNABLE AS A PARTICLE) TO THE NAKED EYE. SAND WE ARE ALL FAMILIAR WITH. GRAVELS (NOT SHOWN) ARE LARGER AND HAVE THEIR OWN SIZE /GRADING SYSTEM
***GRANULAR SOILS**_GRAVELS AND SANDS ARE ANGULAR & GRAINY AND DRAIN WATER READILY, AND ARE NOT SLIPPERY, AND DO NOT BOND. THEY ARE PREDICTABLE. THEY COMPACT (ONLY) WHEN CONSTRAINED.
***COHESIVE SOILS**_ SILTS AND CLAYS. THE SILT PARTICAL IS JUST PLAIN SMALL. THE YET WAY SMALLER CLAY PARTICLE IS UNIQUE BECASUE IT CAN ABSORB WATER, WHICH MAKES IT DIFFERENT AND A BEHAVIORAL PROBLEM. IT SWELLS WHEN IT TAKES ON WATER, AND SHRINKS WHEN IT DRIES. IT IS HARD AS ROCK WHEN DRY AND SLIPPERY AND PLASTIC WHEN WET.
***SILT**_SILT CAN BE CLASSIFIED AS A GRANULAR PARTICLE. ITS SIZE GIVES IT A FLEXIBILITY IN BEHAVIOR. WHEN PRESENT WITH SANDS+GRAVELS IT WORKS (SEE GM+SM). WHEN PRESENT WITH CLAYS IT BECOMES A PARTICIPANT.

FOUNDATION STRUCTURE c2.4
SOIL- BEARING





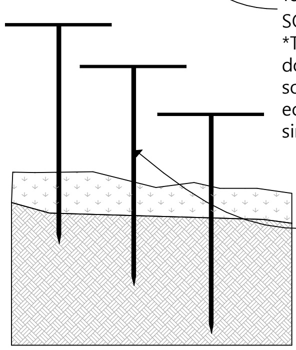
THE (CONTINUOUS) LOAD
*Building gravity loads need to be tabulated from the roof down
*For continuous walls that load is realized in pounds per lineal foot (plf)

DISTRIBUTION thru FOOTING
*Typically loads get distributed from foundation wall to footing to the bearing soil.
*Without specific engineering those loads are transferred thru that footing at a 60º angle
*Loads extend into that soil following that same 60º path

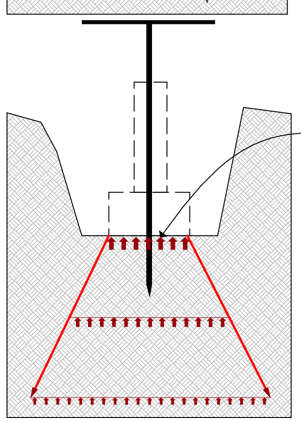
THE CRITICAL ZONE OF COMPACTION
*This immediate 4" to 6" is the most critical for compaction/settlement.
*This bottom of footing is subject to compromise after excavation and before footing pour. Collapsing soft soil falls and should be cleaned out. Rainfall is the big concern as it will effect that soil and can soften in all up. Muck has little bearing capacity and needs also to be cleaned out..

LOAD DECREASES
*'W' represents the footing width.
*Load on the soil is halved at 'W' below footing.
*Load on the soil is 33% at 2 x 'W' below footing.

SOIL DEEP DOWN
*The decreasing load burden is instructive but does not relieve the deep soil of it job. Soft soil and voids deeper down can eventually echo above and cause serious difficulties. think sink holes.



PROBING NATIVE SITE
*This probe check can accompany a site walk as a preliminary verification of soil character & consistency.
*If such a check can be done under dry and wet (sustained rainfall) a little more data can be gleaned.



PROBING AT THE FOOTING
*This probe check at the bottom of the footing dig will absolutely give feedback on consistency.
*Reminder-wet conditions are at this bottom of footing plane want to be understood. Rain, collected rain water happens. If it drains and disappears it is suggesting drainable soil. If it sits, and sits then it is possible there is clay present or a rising water table and caution is recommended.

SOIL CLASSIFICATIONS & BEARING

***CLASSIFICATIONS_**IF A SOIL CAN BE IDENTIFIED A PRESUMPTIVE SOIL BEARING VALUE CAN BE DETERMINED. THE SOIL BEARING VALUE IS IN POUNDS PER SQUARE FOOT (OF RESISTANCE). SUPPORTING FOOTINGS ARE SIZED BASED ON A SOIL BEARING VALUE.

***THE PRESUMPTIVE VALUE** _OUR SOIL CHART SUGGESTS THAT MOST 'MAINSTREAM' SOILS WILL HAVE AN ASOCCIATED PRESUMPTIVE BEARING VALUE OF 1500 PSF, 2000 PSF, OR 3000 PSF.

THE FOOTING CONCEPT

***DISTRIBUTION_** THE PRIME FUNCTION OF THE FOOTING IS TO DISTRIBUTE BUILDING LOADS FROM THE UNIFORM LOAD (EG FOUNDATION WALL) OR A CONCENTRATED LOAD (EG COLUMN OR POST) OVER THE APPROPRIATE AMOUNT OF SOIL AREA SO THAT THE RESISTANCE EQUALS OR EXCEEDS THE LOAD. IF A FOOTING IS NOT LARGE ENOUGH IN AREA THEN THE FORCE OF THE LOAD WILL PUSH THAT FOOTING FURTHER INTO THE GROUND (SETTLEMENT)
***THE SIMPLE MATH_**THE LOAD IS DIVIDED BY THE BEARING VALUE RESULTS IN THE FOOTING AREA OF RESISTANCE. A 6000# LOAD PLACED ON A SOIL RATED AT 1500 PSF REQUIRES 4 SF OF FOOTING AREA. A 6000# LOAD PLACED ON A SOIL RATED AT 2000 PSF REQUIRES 3 SF OF FOOTING AREA. A 6000# LOAD PLACED ON A SOIL RATED AT 3000 PSF REQUIRES 2 SF OF FOOTING AREA.
***LOGIC_**FOOTINGS NEED TO BE LARGER IN SOFTER SOIL. FOOTINGS CAN BE SMALLER IN FIRMER SOIL.
***BUILDING LOADS_**BUILDING WEIGHT (DEAD LOAD) AND OCCUPANT LOADS (LIVE LOAD), CAN BE 'TRACKED' FROM ROOF TOP TO FOOTING RESULTING IN FAIRLY SPECIFIC LOADS BEING UNDERSTOOD AT ALL POINTS WHERE STRUCTURE MEETS GROUND. THE MEETING PLANE IS THE BOTTOM OF THE FOOTING.

DETERMINING ACTUAL ON SITE SOIL BEARING VALUES

***THE SOIL WILDCARD_**SO DETERMINING FOOTING SIZES CAN ONLY BE ACCURATELY REALIZED BY KNOWING THE SOIL BEARING VALUE. OUR CHART IS WELL AND GOOD, BUT ONLY IF ONE CAN VISUALLY (OR TEXTURALLY) DISTINGUISH SOIL TYPES. MOST NON PROFESSIONALS WOULD NOT BE ABLE TO DO THIS WITH CERTAINTY. SO___
***GEOTECHNICAL ENGINEERING TESTS_**THERE ARE ESTABLISHED ENGINEERING TESTS. A LITTLE EXPENSIVE AND NOT VERY COMMON IN RESIDENTIAL PROJECTS BUT OCCASIONALLY A VERY SMART INVESTMENT. FOR THOSE WHO 'NEED TO KNOW' AND THOSE INTENT ON HIGHLY EFFICIENT FOUNDATION DESIGNS IT IS THE BEST ALTERNATIVE.
***ENGINEERS OBSERVATION** _STRUCTURAL AND GEOTECHNICAL ENGINEERS MAY BE WILLING TO MAKE A VISUAL INSPECTION ON A SITE ASSUMING ADEQUATE HOLES OR TRENCHES HAVE BEEN DUG SO THAT VISUAL INSPECTION GETS DOWN TO THE FOOTING ELEVATIONS, AND SOME CROSS SECTION OF THE CUT IS VISIBLE. WITHOUT THE TESTING THE ENGINEER MAY WELL BE RELUCTANT TO OFFER A SPECIFIC BEARING CAPACITY, BUT MIGHT OFFER A THUMBS UP OR THUMBS DOWN KIND OF RESPONSE. LIABILITY HAS A LOT OF DESIGN PROFESSIONALS LEARY OF UNTESTED COMMITMENTS.
***EXPERIENCED TRADESPEOPLE**. _EXCAVATORS, FOOTING CONTRACTORS, AND GENERAL BUILDING CONTRACTORS ARE ALL CANDIDATES FOR GOOD REGIONAL OBSERVATIONS. MOST TRADES PEOPLE ARE NOT ENGINEERS OR DESIGNERS SO ARE RESTRICTED TO SUGGESTING PAST SOLUTIONS THAT HAVE NOT FAILED. MORE OFTEN THAN NOT THESE SOLUTIONS ARE CONSERVATIVE.
***CODE INSPECTORS** _INSPECTIONS ARE REQUIRED (IN MANY COMMUNITIES) PRIOR TO FOOTING INSTALLATION-CHECKING THAT ALL PREPARATIONS ARE IN ORDER. A INSPECTOR MAY CHOOSE TO PROBE THE SOIL UNDER FOOTING LOCATIONS HIMSELF. THE CATCH 22 HERE IS THAT FOOTING WILL ALREADY HAVE BEEN FORMED OR TRENCHED, SO, FOR EXAMPLE IF SOFT SOIL IS ENCOUNTERED SUGGESTING THAT LARGER FOOTINGS ARE IN ORDER, IT COULD RESULT IN A FOUNDATION PREP DO-OVER. WASTEFUL.

FIELD CHECKS

***CONSITENCY_**ONE THING A DIYER CAN DO IS PROBE ALONG A FOOTING LINE AND CHECK FOR CONSISTENT OR INSONSISTENT RESISTANCE. THAT CONSISTENCY/INCONSISTENCY CAN BE A BIGGER ISSUE THAN THE BEARING VALUE BECAUSE OF DIFFERENTIAL SETTLEMENT.
***ACTUAL LOAD BEARING_**THERE ARE A FEW DIY TECHNIQUES-SUCH AS USING A PENETROMETER- THAT CAN BE EMPLOYED BUT ARE MAYBE A LITTLE RISKY. IF IN DOUBT THIS DETERMINATION IS BETTER LEFT TO THE PROS.

SOIL- CAUTIONS, FILL, COMPACTION

SOIL CAUTION SUMMARY

***CAUTION1 IS ORGANIC SOILS (<1500 PSF)**_DARK IN COLOR AND HIGH IN WATER AND AIR, AND SOFT EVEN TO WALK ON. A PROBE WILL SINK. SOIL TESTS AND ENGINEERING REQUIRED TO DESIGN A PILE OR SPREAD FOOTING FOUNDATION SOLUTION.

***CAUTION 2 IS 'ROCK' (>3000)**_THE BEARING CAPACITY IS THERE BUT A FOUNDATION CONDITION THAT MOVES FROM SOIL TO ROCK, SOIL TO ROCK PRESENTS AN INCONSISTENCY THAT REQUIRES ENGINEERED DESIGN. FOUNDATIONS ON ALL ROCK REQUIRE NON CONVENTIONAL CONSTRUCTION AND ALSO REQUIRE ENGINEERED DESIGN.

***CAUTION 3 IS INCONSISTENCY**_AS NOTED ALL STRUCTURES SETTLE, IF EVEN A TINY AMOUNT. IF THE WHOLE STRUCTURE SETTLES TOGETHER THERE ARE USUALLY NO MAJOR PROBLEMS. IF THE PROJECT SETTLES UNEQUALLY (DIFFERENTIAL SETTLEMENT) PROBLEMS SURELY CAN ARISE.

***CAUTION 4 IS CLAY**_CLAY WANTS TO BE IDENTIFIED, EITHER BY TESTING OR DURING/AFTER EXCAVATION. EXTENT AND LOCATION WILL DETERMNE BEST PROCEDURE. SEE AMENDING SOIL BELOW.

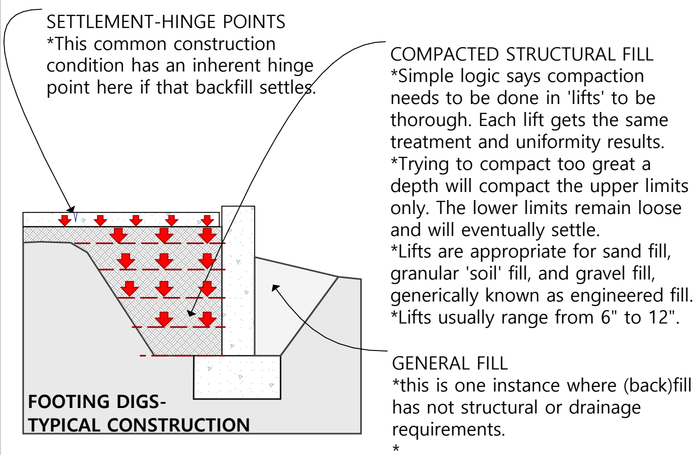
DEFAULT THINKING

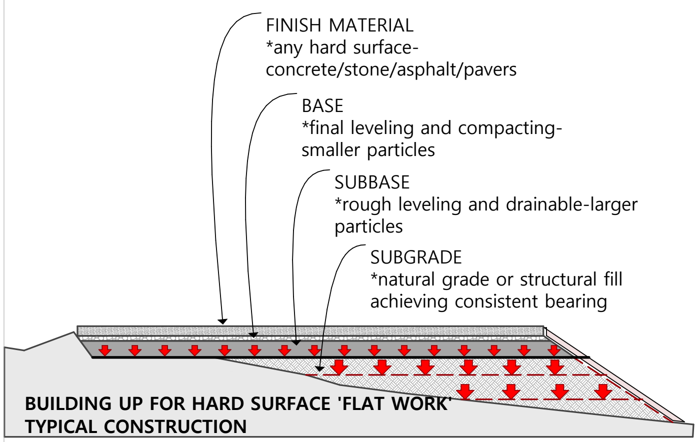
***RECOGNIZED SOIL**_IF A SOIL IS TESTED, OR IF AN ACCURATE VISUAL IDENTIFICATION HAS BEEN MADE SUCH THAT A CERTAIN DESIGN BEARING CAPACITY IS DETERMINED THEN ALL FOOTING REQUIREMENTS CAN BE DESIGNED BASED ON THAT BEARING CAPACITY.

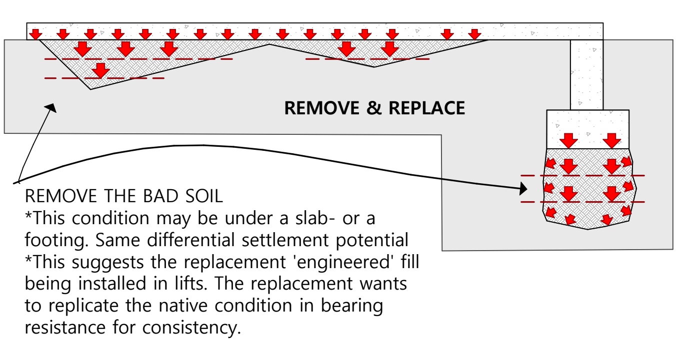
***2000 PSF DEFAULT**_WHEN THAT SPECIFIC BEARING CAPACITY IS NOT DETERMINED THE HOME BUILDING INDUSTRY AND THE IRC CODE HAS ADOPTED A 2000 PSF AS A DEFAULT SOIL BEARING VALUE. THE EXCEPTION HERE CLEARLY IS WHEN SILTS AND CLAYS ARE IDENTIFIED CHARACTERISTIC OF SOIL TYPES ML, CL, CH, MH WHEREIN FURTHER INVESTIGATION IS IN ORDER.

***THESE DESIGN DAWINGS**_ALL FOOTINGS IN THIS SYSTEM ASSUME THAT 2000 PSF VALUE AND ARE SO SIZED. THESE ASSUMED VALUES DO HAVE A BUILT IN FACTOR OF SAFETY-OR IN OTHER WORDS ARE INHERENTLY CONSERVATIVE.

***CONSTRUCTION FAILURES**_RESIDENTIAL CONSTRUCTION, BECAUSE OF THE FACTOR OF SAFETY, AND THE HELPING HAND NATURE OF THE LIGHT LOAD RESIDENTIAL FRAME CONSTRUCTION ITSELF, IS PRETTY FORGIVING. FOOTING AND FOUNDATION FAILURES ARE ALMOST ALWAYS A RESULT PURE CARELESSNESS. BUILDING ON HIGHLY INCONSISTENT SOILS, PLASTIC SOILS, AND LOUSY SITE WATER MANAGEMENT ARE THE FAILURE CULPRITS. THERE IS NO EXCUSE NOT TO IDENTIFY THESE CONDITIONS AND DEAL WITH THEM.







TERMINOLOGY

***DEFINING THE FILL DESIGN REQUIREMENT**_THERE ARE 3 JOBS THAT FILL MAY NEED TO PERFORM. BACKFILL SOME USE AS A GENERAL TERM TO COVER ALL FILL REQUIREMENTS. BUT THAT TERM NEEDS QUALIFICATION BASED ON THE JOB IT IS DOING.

***STRUCTURAL FILL**_IS PERFORMING A STRUCTURAL JOB AND MOST OFTEN WANTS TO ACHIEVE THE SAME BEARING CAPACITY AS THE BALANCE OF THE PROJECT SOIL THAT IS IN A STRUCTURAL SUPPORT ROLE. THIS FILL MAY ALSO BE REFERRED TO AS 'ENGINEERED' FILL, OR POSSIBLY 'COMPACTED' FILL. UNIFORMITY IS KEY.

***STRUCTURAL/DRAINAGE (UNIVERSAL) FILLS**_JUST TO CONFUSE THINGS THERE ARE INSTANCES, FOR EXAMPLE UNDER SLABS, WHERE A STRUCTURAL AND A DRAINAGE FUNCTION ARE REQUIRED. GRANULAR FILLS LIKE CRUSHED STONE CAN DO THIS.

***DRAINAGE FILL**_A LOT OF FILLS MAY HAVE THE INTENDED PURPOSE OF PASSING WATER/MOISTURE ALONG. EXTERIOR BASEMENT BACKFILLS AND DRAINAGE DITCHES ARE OBVIOUS ONES.

***OTHER FILL**_ALL OTHER FILL THAT IS NOT PERFORMING A STRUCTURAL NEED OR A SPECIFIC DRAINAGE NEED, MIGHT FALL UNDER AN UMBRELLA USING THE TERM 'BACK' FILL, 'SITE' FILL, OR 'GENERAL' FILL. LESS CRITICAL BUT NONETHELESS FULFILLING A TASK, WHICH MEANS THERE ARE CONDITIONS FOR PROPER SELECTION AND INSTALLATION.

STRUCTURAL FILLS

***MATERIAL**_GRANULAR SOILS, GRAVEL AND SAND ARE ALL COMMON AND CAN DO THE JOB. REFERENCING THE USCS SOIL CHART IT IS THE 'RED ZONE' SOILS THAT ONE DOES NOT WANT TO USE. SOMETIMES ON SITE EXCAVATED SOIL IS A GOOD CANDIDATE FOR STRUCTURAL FILL,.SOMETIMES IT IS QUESTIONABLE, TOO MIXED, OR TOO WET, AND ELECTING TO BUY AND INSTALL A GRAVEL IS FAR SMARTER.

***INSTALL IN APPROPRIATE LIFTS**_LIFTS USUALLY BETWEEN 6-12" ARE COMMOM. GRAVELS MAY ALLOW DEEPER LIFTS.

***VIBRATION/COMPACTION**_ROLLER TYPE, PLATE COMPACTORS, AND RAMMERS ARE ALL 1 MAN VIBRATING COMPACTION MACHINES. EACH HAS A BETTER USE DEPENDING ON AREA BEING COMPACTED AND THE FILL MATERIAL.

***MOISTURE**_A CONTROLLED AMOUNT OF MOISTURE CAN PLAY A BIG ROLE, AGAIN, DEPENDENT ON THE MATERIAL. TOO WET OR TOO DRY AND MATERIALS WON'T BIND WHICH CAN PREVENT THEM FROM REACHING THE BEARING CAPACITY DESIRED.

***ASSURED SETTLEMENT**_YOU DO NOT WANT TO JUST FILL UP A HOLE OR DEPRESSION-EVEN WITH GRAVEL. IT WILL SETTLE. YOU DO NOT WANT TO USE ANY FILL WITH GARBAGE OR ORGANICS. IT WILL SETTLE. YOU DO NOT WANT TO USE ANY SIGNIFICANT ANOUNT OF EXPANSIVE CLAY. IT WILL SHRINK AND SETTLE.

DRAINAGE FILLS

***MATERIAL**_EXCAVTED SOILS MAY BE SUITABLE IN SOME DRAINAGE BASED FILL SITUATIONS. BUT THE RIGHT GRAVEL IS A SURE BET. SEE (c2.6)

AMENDING QUESTIONABLE SOIL FOR CONSISTENT BEARING

***EXCLUDING CLAY REMIXING**_CLAYS CAN BE RE-MIXED. THIS IS A TECHNICAL SPECIALTY AND REQUIRES APPROPRIATE TECHNICAL EXPERTISE.

***REMOVE & REPLACE**_IS FAR MORE COMMON IN RESIDENTIAL WORK. THIS ILLUSTRATION IS SUGGESTING THAT 2 COMMON CONDITIONS MAY BE REMOVAL OF SOFT/QUESTIONABLE SOILS UNDER FOOTING, AND UNDER SLAB.

FOUNDATION STRUCTURE c2.6
GRAVEL- FUNCTIONS, SIZES, SHAPES

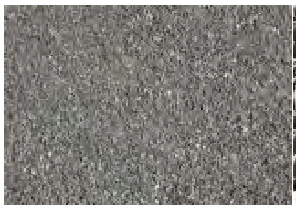
GRAVEL

***ALL GRAVEL IS LOCAL**_GRAVEL IS MINED AND TRUCKED LOCALLY. SO THE STONE'S GEOLOGICAL COMPOSITION, CHARACTERISTICS, COLORS, AND ITS NOMENCLATURE IS SIMILARLY LOCAL.

***GRAVEL IS A CONSTRUCTION WONDER DRUG**_GRAVEL CAN ASSIST SOLVING A LOT OF CONSTRUCTION PROBLEMS & CONDITIONS. WHAT MAKES IT SO EFFECTIVE IS THAT IT CAN BE SELECTED TO SOLVE SPECIFIC PROBLEMS, **IS PERFORMANCE PREDICTABLE**, CAN BE PURCHASED IN CHOSEN QUANTITIES, AND IS PRETTY REASONABLE FROM A COST STANDPOINT. THE 2 MOST IMPORTANT FUNCTIONS OF FILL BEING ACHIEVING STRUCTURALLY CONSISTENT BEARING, AND DRAINAGE, CAN BE PREDICTABLY ADDRESSED WITH GRAVEL. SOIL IS NOT ALWAYS SO PREDICTABLE.

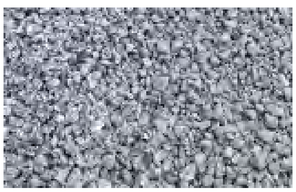
#1 CRUSHED STONE

'WASHED' GRAVEL



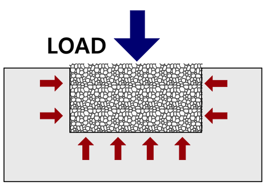
REAL SMALL STUFF-'FINES'

MIXED UP-'BANK RUN'

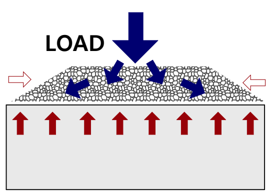


#57 CRUSHED STONE

#57
*3/4"+/-.a great universal gravel for drainage, sub base, and fill for a variety of uses. without fines it drains well. with the right amount of fines it can be compacted to a dense impervious surface



CONSTRAINED



UNCONSTRAINED

COMPACTION TOOLS

VIBRATING ROLLER
*well suited to unconfined flat work areas

PLATE VIBRATOR, RAMMER
*common 1 man compaction tools.
*soil type and confinement of area are 2 criterion for appropriate choice

RIP RAPS

'WASHED' GRAVELS

GRAVEL-TERMS & CONDITIONS

***ANGULAR GRAVEL**_WHEN ROCK IS CRUSHED IT BECOMES SMALLER AND ANGULAR AND IS FREQUENTLY REFERRED TO AS 'CRUSHED' GRAVEL (MORE ACCURATELY CRUSHED STONE). ANGULAR GRAVEL, REGARDLESS OF SIZE, WILL 'LOCK' TOGETHER.

***ROUNDED GRAVEL**_ROUNDED GRAVELS ARE FOUND IN A NATURAL STATE AND MINED/EXCAVATED (NOT CRUSHED). THE ROUNDED GEOMETRY IS A CONDITION OF SOME TYPE OF EROSION. ALSO REFERRED TO AS WASHED GRAVEL, RIVER WASH, CREEK ROCK, BEACH GRAVEL, PEA GRAVEL, BANK GRAVEL. GRAVEL GEOMETRY MAY BE SPHERICAL TO VERY OBLONG. THE SMOOTH EDGES OF THESE ROCKS PROHIBIT 'LOCKING'.

***FINES**_A GENERALLY RECOGNIZED TERM FOR THE REALLY SMALL STUFF. IT MIGHT BE A BIT SHARP AND ANGULAR, OR A SOFTER NATURAL SAND, OR EVEN SMALLER AND CLOSE TO BEING A DUST. ITS SMALL SIZE IS THE KEY, AND CAN BE EMPLOYED ON ITS OWN OR IN A GRAVEL MIX. THE FINENESS IS A DESIGN COMPONENT OF A 'MIX'.

***VOIDS**_EITHER SHAPE OF GRAVEL WHEN CONSISTENT IN SIZE WILL HAVE A LOT OF VOID SPACE BETWEEN THE PARTICLES OF GRAVEL. THE VOID SPACE IS WHAT WILL PASS WATER. MIXING EITHER ANGULAR OR ROUNDED STONE WITH DIFFERENT SIZES WILL REDUCE THE AMOUNT OF VOID, TIGHTEN UP THE 'MIX', AND PASS LESS WATER. WHEN MIXED WITH DIFFERENT SIZES INCLUDING 'FINES', THE 'MIX' (WITH COMPACTION) CAN BECOME REAL SOLID AND FAR MORE IMPERMEABLE. THE FINENESS OF THE FINES CONTROLS THE IMPERMEABILITY.

***SIZES**_THERE IS A SIZE PECKING ORDER OF 'STONE PARTICLE' DESCRIPTORS FROM BIG TO SMALL-BOULDER, COBBLE, COARSE/MEDIUM/FINE/VERY FINE GRAVELS, COARSE/MEDIUM/FINE/VERY FINE SANDS. SILT AND CLAY SOIL PARTICLES ARE SMALLER STILL BY A GOOD BIT. ALL PARTICLE CLASSIFICATIONS DO HAVE SPECIFIC DIMENSIONAL PARAMETERS.

***CONSTRAINED INSTALLATIONS**_ARE INSTALLATIONS WHERE GRAVEL IS PLACED WITHIN A STRUCTURALLY SECURE BOUNDARY, ELIMINATING ANY HORIZONTAL SPILL/SLIDING. THINK SAND IN A SANDBOX. IF THE BOUNDARY BOX IS STONG ANYTHING CAN BE DUMPED IN AND PUT UNDER PRESSURE. A FORCED SETTLEMENT OR COMPACTION CAN BE ACHIEVED.

***UNCONSTRAINED INSTALLATIONS**_ARE INSTALLATIONS WHERE THERE IS NO STRUCTURALLY SECURE BOUNDARY ALLOWING HORIZONTAL SPILL/SLIDING. THINK SAND WITHOUT A SANDBOX. IN THIS SITUATION ROUNDED STONES DON'T WORK AT ALL, EQUAL SIZE ANGULAR STONE WILL HOLD A SHAPE, MIXED GRADE ANGULAR STONE CAN BE COMPACTED AND HOLD A SHAPE. SUCCESS OF FORCED SETTLEMENT OR COMPACTION THEN IS A CONDITION OF THE MATERIAL GEOMETRY AND SIZE(S).

***PERMEABLE AND IMPERMEABLE COMPACTIONS**_PICTURE ANY SIMILAR SIZED ROUND OR ANGULAR GRAVEL IN A CONSTRAINED CONDITION WITH PRESSURE ABOVE. FORCED SETTLEMENT WILL OCCUR AS THE GRAVEL REPOSITIONS ITSELF UNTIL IT JUST CAN'T ANYMORE. A STRUCTURAL BASE HAS BEEN ACHIEVED THAT STILL HAS PLENTY OF VOID FOR ANY DRAINAGE REQUIREMENTS-PERMEABLE COMPACTION. PICTURE A MIXED SIZE OF GRAVEL INCLUDING FINES WITH PRESSURE FROM ABOVE WHERE THE SIZES ARE INTERMIXING AND THE FINES ARE FILLING ALL THE VOIDS. THIS COMPACTED RESULT ACHIEVES A STRUCTURAL BASE, AND IS VERY RELUCTANT TO DRAIN WATER AS THE VOIDS HAVE BEEN FILLED WITH FINES- IMPERMEABLE COMPACTION. BOTH COMPACTED- BUT EACH HAVING A DIFFERENT JOB.

CONSTRUCTION GRAVEL SELECTION BY FUNCTION & CONDITION

***SO MANY CHOICES**_GRAVELS ARE AVAILABLE IN A LOT OF SHAPES, SIZES, MIXES AND COLORS. ONE MUST FIRST DEFINE THE PROBLEM TO BE SOLVED BEFORE SELECTING THE BETTER PRODUCT. THERE ARE SOME GOOD WEB SITES THAT OFFER A COMPLETE TERMINOLOGY, AND DESCRIPTION WITH PICTURES. NOTED IS THE UBIQUITOUS #57 WHICH IS PRETTY FLEXIBLE (AND CAN BE SHOVELED).

LANDSCAPE GRAVEL BY FUNCTION AND APPEARANCE

***ABOVE GRADE DRAINAGE**_DITCHES LINED WITH STONE CAN MOVE VARYING VOLUMES OF WATER. AGRESSIVE FLOW WANTS AN ANGULAR INTERLOCKING LARGER STONE SUCH AS 'RIP RAP' OR BALLAST. MODEST FLOW MAY UTILIZE A MORE ATTRACTIVE WASHED STONE AS LONG AS THE DITCH BASE IS EROSION PROTECTED.

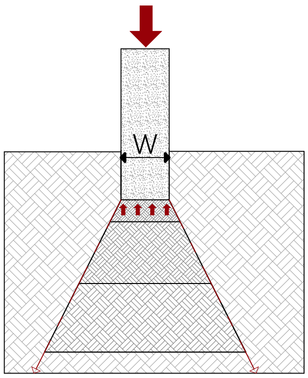
***CONTROLLING GRADE**_SLOPED GRADE CAN BENEFIT FROM THAT SAME RIP-RAP TO CONTROL EROSION & STABILZE. RIP RAP WORKS ITS WAY INTO & INTEGRATES WITH THE SOIL. OTHER FANCIER INSTALLATIONS OF SLOPE SURFACE STONE ARE AVAILABLE. THESE ARE ALTERNATIVES TO RETAINING WALLS.

***EXPOSED SURFACES**_GARDEN BEDS, WALKWAYS & DRIVE SURFACES ALL ARE GRAVEL CANDIDATES. AESTHETICS ARE A BIG DEAL, BUT ALSO CONSIDER INTERLOCKING STABILITY, RAKING, THE FORCE OF LEAF BLOWERS. SIZE & SHAPE ARE MAINTENANCE FACTORS FOR SURE.

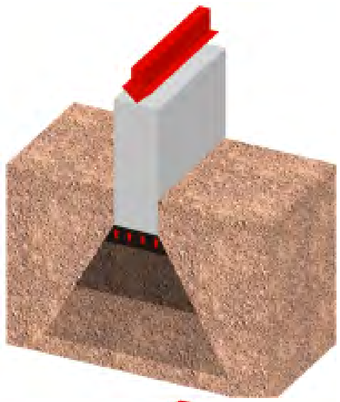
THE JOB OF THE FOOTING

***DISTRIBUTION TO SOIL_**BUILDING LOAD IS RECIEVED AT THE TOP OF THE FOOTING AND DISTRUBUTED TO THE BOTTOM OF THE FOOTING. THE WIDTH OF THAT FOOTING WHERE IT MEETS SOIL IS THE PRIMARY DESIGN CRITERION. THE TAKEAWAY INTENDED BELOW IS TO GET COMFORTABLE WITH THE DISTRIBUTION IDEA. REPEATED ONE MORE TIME IS THAT WHEN A LOAD

***DISTRIBUTION THRU SOIL_**THE SOIL BELOW THE FOOTING UNIFORMLY SUGGEST A CONTINUATION OF LOAD DISTRIBUTION AT 60°. THAT IS AN ACCEPTED STANDARD. SITE SPECIFIC SOIL ENGINEERING MAY INDICATE THIS TO BE A LITTLE MORE OR LESS. BUT THE DESIGN PROBLEM FOR THE WIDTH OF THE FOOTING SHOULD BE RESOLVED AT THE BOTTOM PLANE OF THE FOOTING BASED ON BEARING VALUE AT THAT PLANE.



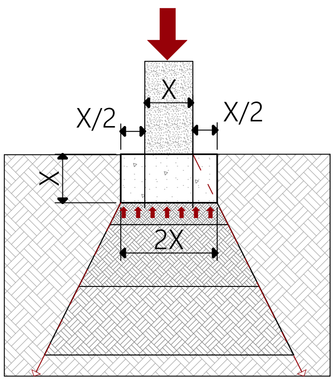
PLAIN CONCRETE



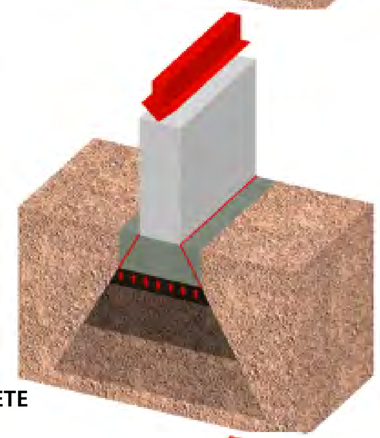
WALL AS FOOTING

***BEARING 'W'_**THE PRICIPLE OF BEARING REMAINS THE SAME. THE WALL IS THE FOOTING. THE WALL WIDTH IS THE FOOTING WIDTH. NOTHING WRONG WITH THIS IF THE WIDTH IS ADEQUATE.

***EXAMPLES_**ASSUMING THE 2000 PSF BEARING CAPACITY AN 8" WALL CAN SUPPORT 1320 PLF, A 10" WALL CAN SUPPORT 1660 PLF, AND A 12" WALL CAN SUPPORT 2000 PLF.



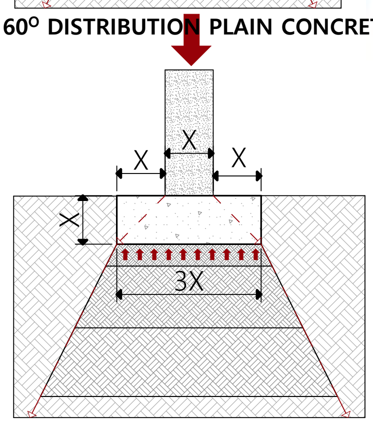
60° DISTRIBUTION PLAIN CONCRETE



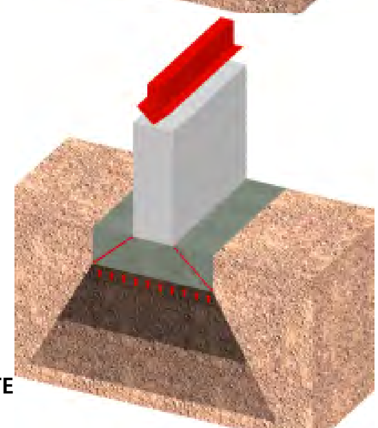
60° PROJECTION STANDARD THRU THE FOOTING

***CONSERVATIVE STANDARD_**IS THE 60° LOAD TRANSFER PROJECTION THRU FOOTING GETS US A BEARING WIDTH AT THE BOTTOM OF FOOTING. THE 'X' WALL WIDTH IS A STARTING PLACE. SO AN 8" WALL WANTS AN 8" DEEP FOOTING AND A 16" FOOTING WIDTH WITH 4" OF PROJECTION. A 10" WALL WANTS A 10" DEEP FOOTING AND A 20" WIDTH WITH 5" PROJECTION, ETC..

***FACTOR OF SAFETY_**BECAUSE MOST RECOGNIZE THAT EVEN PLAIN CONCRETE HAS AN EFFECTIVE DISTRIBUTION OF 45°, THIS PROPORTIONAL FORMULA INCORPORATES A FACTOR OF SAFETY OF 33% WHICH IS A COMFORTABLE MARGIN.



45° DISTRIBUTION PLAIN CONCRETE

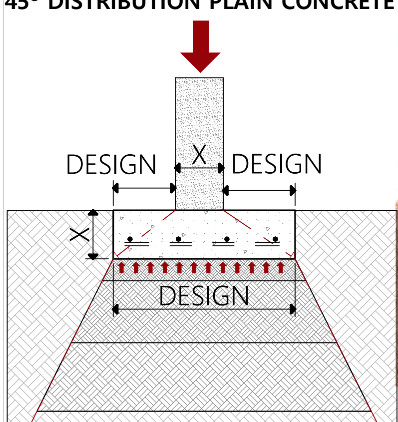


45° MAX PROJECTION FOR PLAIN CONCRETE

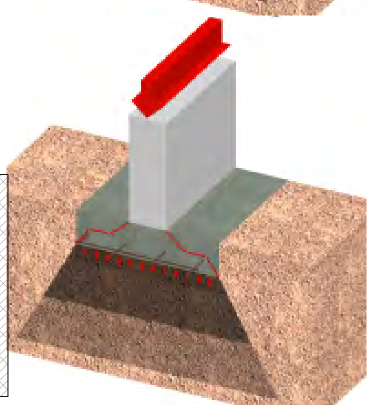
***SAVE SOME CONCRETE_**USING THIS GREATER DISTRIBUTION STANDARD WOULD HAVE AN 8" WALL, AN 8" DEEP FOOTING, AND A 24" WIDE FOOTING CARRYING 33% MORE LOAD THAN THE MORE CONSERVATIVE STANDARD ABOVE.

***PROJECTION_**THIS RELATIONSHIP IS THE MAX THE CODE ALLOWS SHORT OF THE REINFORCEMENT/ENGINEERING NOTED BELOW.

***24" FOOTING WIDTH_**IS SEEN A LOT- SSOMETIMES BECAUSE OF LOCAL HABIT AND OR LOCAL BACKHOE BUCKET WIDTH! WITH 2000 PSF SOIL BEARING THE FOOTING CAN TAKE 4000 PLF WALL LOAD WHICH IS A LOT OF HOUSE SITTING ABOVE. POINT BEING 24" W FOOTINGS ARE USUALLY USING MORE CONCRETE THAN IS NECESSARY.



THE REINFORCED 'SPREAD' FOOTING



REINFORCED/SPREAD FOOTINGS

***INCREASING 'W'_**REINFORCEMENT INCREASES THE WIDTH DISTRIBUTION A LOT. THIS MAY BE VAIBLE IN SOFTER SOILS, USUALLY NOT REQUIRED FOR CONTINUOUS FOOTING WITH DECENT SOIL AND NORMAL LOADING.

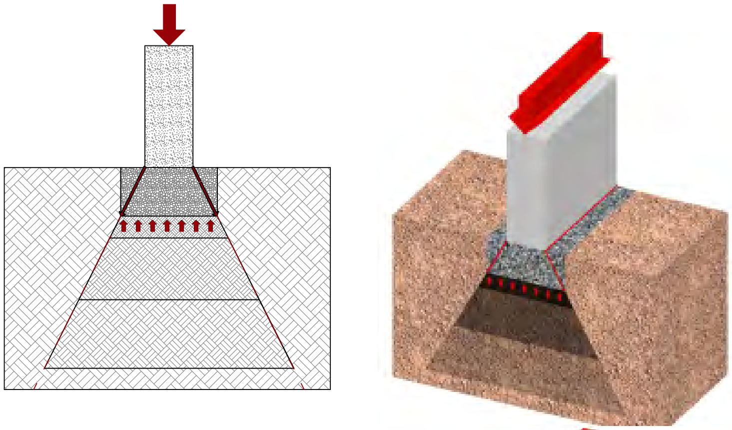
***10" DEPTH REQUIRED_**THE ACI (AMERICAN CONCRETE INSTITUTE) RECOMMENDS 10" DEPTH WITH 3" OF CONCRETE 'COVER' FOR THE REINFORCEMENT ON THE BOTTOM OF FOOTING. THIS ALLOWS THE REINFORCEMENT TO DO ITS JOB.

***GENERAL FOOTING REINFORCEMENT NORMS_**LONGITUDINAL REINFORCEMT USUALLY #4, OR #5 AT 7" OR 8" ON CENTER. TRANSVERSE REINFORMENT WIRED TO THE LONG MENBERS AT 24" TO 36" ON CENTER.

FOOTING CONSTRUCTION

***DEPTH_**TYPICAL RESIDENTIAL CONCRETE FOOTINGS ARE 8", 10", OR 12" DEEP. AS NOTED BELOW 10" DEPTH IS RECOMMENDED WHEN REINFORCEMNT IS USED.

***REINFORCEMENT_**SPREAD FOOTINGS REQUIRE REINFORCEMENT TO ACHIEVE THE DISTRIBUTION THEY ARE DESIGNED FOR. FOOTINGS STAYING WITHIN THE 45° DISTRIBUTION RULE DO NOT NECESSARILY NEED REINFORCEMENT. IF SOIL BENEATH THE FOOTING IS ADEQUATE AND UNIFORM AND THE FOOTING THEREFORE IN COMPRESSION ONLY, THEN REINFORCEMENT IS NOT NECESSARY. IF SOIL IS INCONSISTENT OR QUESTIONABLE THEN REINFORCEMNT MAY BE CALLED FOR. SO THE FOOTING CAN FUNCTION AS BEAM WHEN NEEDED. SOME BUILDERS USE REINFORCEMENT OUT OF HABIT, MAYBE JUST OUT OF HABIT OR BECAUSE IT IS EASIER THAN PROPERLY PREPARING THE BED OF THE FOOTING.

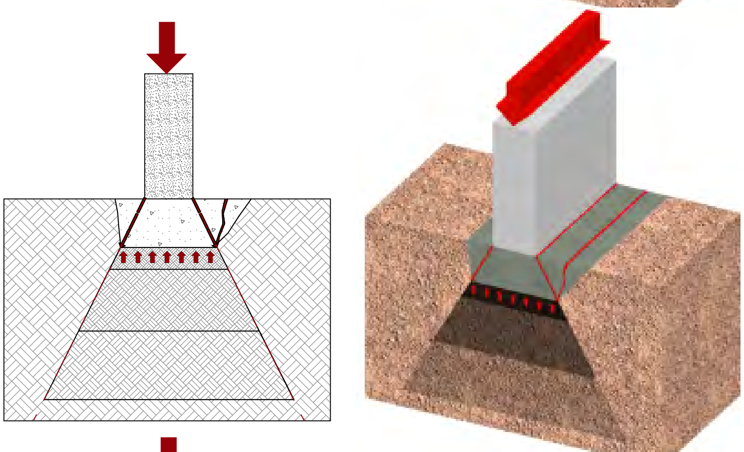


TRENCH POUR GRAVEL FOOTINGS

***PROCEDURE_**THE APPROPRIATE WIDTH TRENCH IS CAREFULLY DUG. THE TRENCH IS THE CONSTRAINED BOX THAT THE GRAVEL WILL BE COMPACTED WITHIN. 60° IS THE MAX DISTRIBUTION FOR A GRAVEL FOOTING SO THE WIDTH TO DEPTH PROPORTION OF THE FOOTING DIMENSION CANNOT EXCEED THAT 2:1 RATIO.

***CAUTIONS_**STEP FOOTINGS ARE A CONCERN AS THERE IS A STRUCTURAL 'GAP' WHERE THE STEPS OCCUR AND THE FDN WALL HAS TO 'SPAN' THAT GAP. THE TRENCH SOIL NEEDS TO BE SUITED TO FUNCTIONING AS A CONTAINER

***OTHER APPLICATIONS_**GRAVEL FOOTINGS HAVE INSTANCES WHERE THEY ARE HELPFUL/PREFERRED. PRECAST CONCRETE FOUNDATION WALL SYSTEMS AND PERMANENT WOOD FOUNDATION SYSTEMS RECOMMEND THEM. (DETAIL A LITTLE DIFFERENT). WET CONDITIONS ALSO USE OVERDUG GRAVEL FOOTINGS

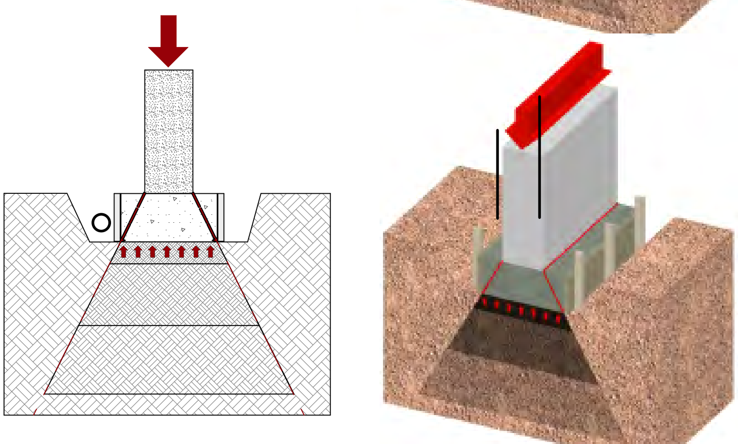


TRENCH POURED CONCRETE FOOTINGS

***PROCEDURE_**CLEANLY DUG FOOTING TRENCH WITH LEVEL TOP MAKES FOR A SIMPLE AND INEXPENSIVE FOOTING ELIMINATING ALL FORMWORK LABOR AND EXPENSE. FOOTING WIDTH BECOMES A CONDITION OF THE EXCAVATOR'S BUCKET SIZE(S)-SO WASTED CONCRETE FREQUENTLY A GIVEN.

***CAUTIONS_**IDEALLY A PERIMETER FOUNDATION DRAINAGE TILE WANT BE BE ADJACENT TO THE FOOTING, NOT ABOVE IT. THIS IS NOT POSSIBLE WITH THE TRENCH POUR.

***FOUNDATION WALL TYPE_**TRENCH POURS SYMPATHETIC TO BLOCK FOUNDATION WALL CONSTRUCTION. NOT SO COMMOM WITH FORMED CONCRETE WALLS WHERE FORMING AND REINFORCEMENT IS AN INTEGRAL PART OF THE WHOLE PROCESS.



FORM POURED FOOTINGS

***WIDTHS_**NOT HAVING TO RELY ON A BUCKET WIDTH ALLOW EACH WALL RUN TO BE SIZED EXACTLY AS REQUIRED, RESULTING IN A UNIFORM LOAD PER SQUARE FOOT ON THE SOIL.

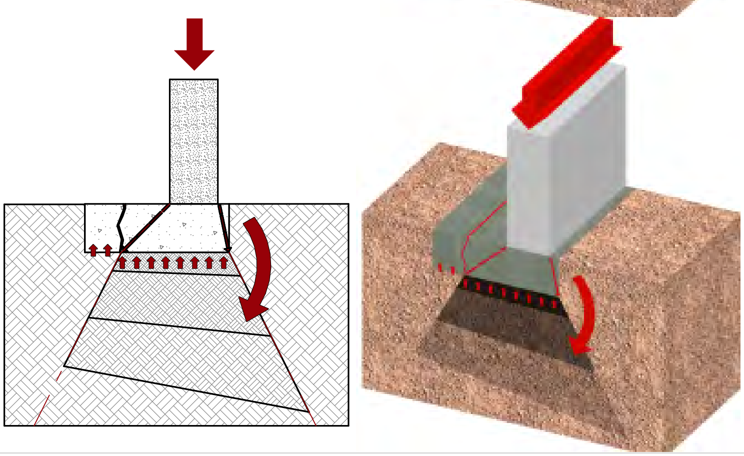
***CONCRETE_**GIVEN THE ABOVE THERE IS NO WASTED CONCRETE

***DRAIN TILE_**AS/IF NEEDED CAN BE PLACED NEXT TO THE FOOTING WHERE IT BELONGS

***DISTRIBUTION_**CAN BE SELECTED (45°-60°) AND MORE CAREFULLY EXECUTED.

***EXCAVATION_**ROOM FOR FORMING REQUIRED THEREFORE EXCAVATED AREA GREATER THAN FOR A TRENCH POUR (USUALLY). THIS MAY OR MAY NOT BE A LIABILITY

***COST_**FORMING IS AN EXTRA STEP AND THE 'SAVED' CONCRETE TYPICALLY WON'T PAY FOR THAT.

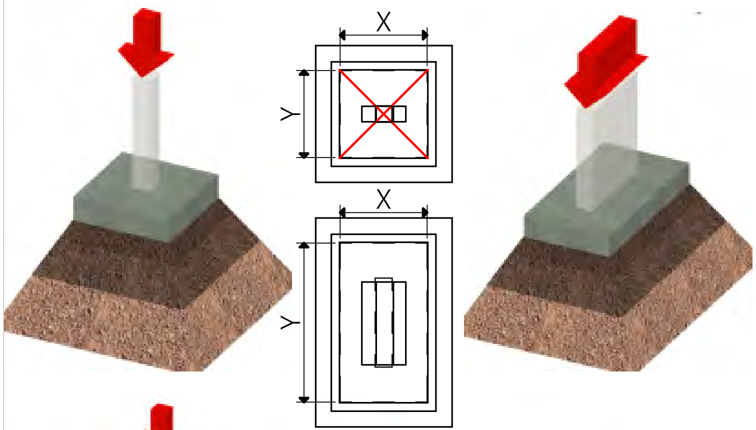


PROJECTIONS/OFF CENTER LOADING/ROTATION

***LAYOUT_**WHETHER TRENCH OR FORMED, FOOTING LAYOUTS HAVE A HABIT OF GETTING OFF WHACK. ONCE A FOOTING IS POURED THE SURVEYOR WILL THEN COME BACK AND 'PIN' THE BUILDING CORNERS VERY PRECISELY. THIS MAY SHOW SOME OFF CENTER INCONSISTENCIES

***OFFSET PROBLEMS_**OFFET LOADING RUNS A THEORETICAL RISK OF 'ROTATION' AN OVERTURNING OF THE FOOTING. UNDER SOME REAL WORLD LOADING CONDITIONS THIS COULD BE A REAL PROBLEM. MOST OF THE TIME NOT A STRUCTURAL ISSUE WITH CONTINUOUS FOOTINGS BUT BEWARE INSPECTORS USUALLY TAKE EXCEPTION TO LESS THAN 2" OF FOOTING PROJECTION, AND GENERALLY DON'T LIKE OFSET SITUATIONS,

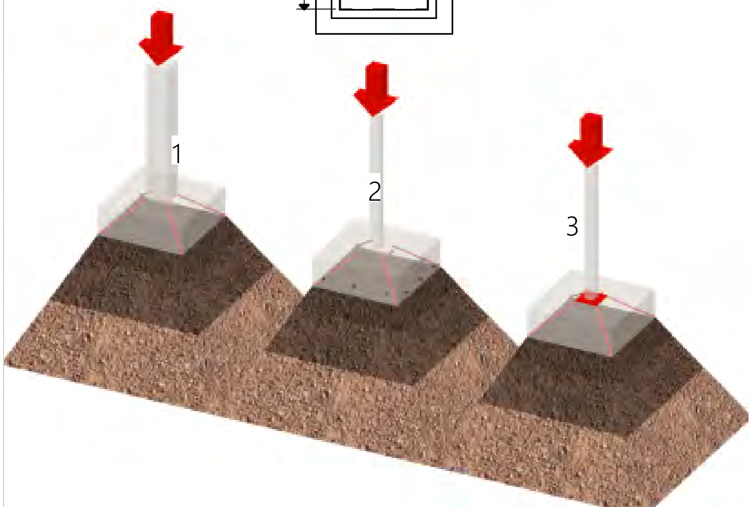
***FIXES_**AN ENGINEER MAY BE REQUIRED TO RE-VISIT SPECIFIC LOADING CONDITIONS TO DETERMINE RISK. FOOTINGS CAN BE WIDENED AND NEED TO BE DOWELLED TO THE EXISTING TO BE OF ANY VALUE.

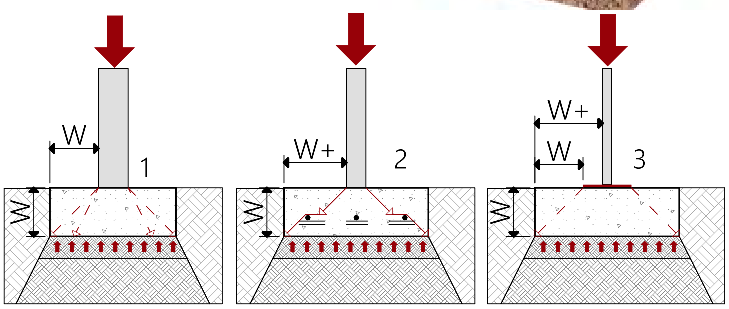


BEARING SQUARE FOOTAGE

***SEARCHING FOR 'X' & 'Y'**_THE MATH FOR THE INDEPENDENT FOOTING IS SIMILARLY PRETTY SIMPLE. THE AREA OF THE FOOTING IN IMMEDIATE CONTACT WITH THE SUPPORTING SUBGRADE IS MULTIPLIED BY THE SUBGRADE'S BEARING CAPACITY EQUALING THE LOAD CAPACITY. THE DESIGN PROCESS WOULD FIRST CALCULATE THE LOAD, AND DIVIDE THAT LOAD BY THE SOIL'SBEARING CAPACITY. THE RESULT IS THE AREA OF FOOTING REQUIRED.

*** DISTRIBUTION GEOMETRY**_THE SHAPE/PROPORTION OF THE POST OR PIER WILL SUGGEST A SIMILAR SHAPE/PROPORTION FOR THE FOOTING WHICH IS MOST EFFICIENT. KEEPING THE 'PROJECTION' EQUAL ALL AROUND THE SUPPORTING MEMBER WILL DISTRUBUTE THAT LOAD IN A BALANCED FASHION. THE DISTRIBUTION INTO THE SOIL IS PYRAMIDAL.





PLAIN CONCRETE REINFORCED CONCRETE BEARING PLATE

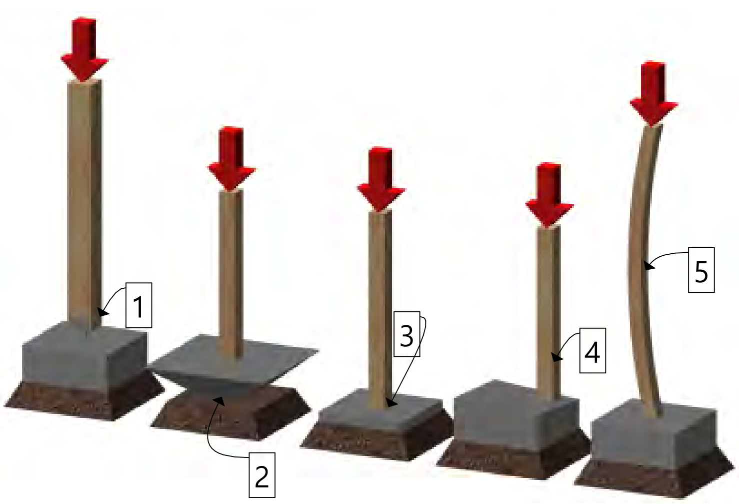
DISTRIBUTION THRU THE FOOTING

***SIMILARITIES TO CONTINUOUS FOOTING**_THE DISTRIBUTION PRINCIPLES ARE THE SAME, EXCEPT THEY ARE OCCURING IN THE 'X' AND 'Y' DIMENSIONS.

1*PLAIN CONCRETE DISTRIBUTION_60° CONSERVATIVE AND THE MAXIMUM 45° DISTRIBUTION LINE FOR PLAIN CONCRETE HOLD. WHEN THE PROJECTION W DOES NOT EXCEED THE DEPTH W THEN REINFORCEMENT IS NOT REQUIRED.

2*REINFORCED FOOTINGS_WHEN THE PROJECTION EXCEEDS THE FOOTING DEPTH THEN REINFORCEMENT MUST BE CONSIDERED. THE IDEA IS THE REINFORCEMENT CAN 'SPREAD' THE LOAD- A SPREAD FOOTING. BEYOND THE 3" COVER RULE- THERE ARE ADDITIONAL AND STRUCTURALLY MORE SOPHISTICATED REINFORCEMENT RULES.

3*BEARING PLATES_BEARING PLATES SPREAD A LOAD OUT IMMEDIATELY TO THE TOP OF A FOOTING THEREBY CHANGING THE PROJECTION 'W'. IF ONE THINKS OF THE BEARING PLATE AS A STEPPED DISTRIBUTION TOOL THERE ARE A VARIETY OF OUTSIDE THE BOX APPLICATIONS. THE CONVENTIONAL EXAMPLE IS THE THIN STEEL COLUMN, WHICH IS CAPABLE OF A SIGNIFICANT LOAD, NEEDING THAT PLATE TO ALLOW A FOOTING TO DO ITS JOB. THE PLATE ITSELF **MUST** BE RIGID. WITHOUT THE PLATE, IN THIS EXAMPLE, THE FOOTING MAY FLEX, OR THE COLUMN FOOTPRINT COULD 'PUNCH' INTO THE CONCRETE.



STRUCTURAL FAILURE POTENTIAL

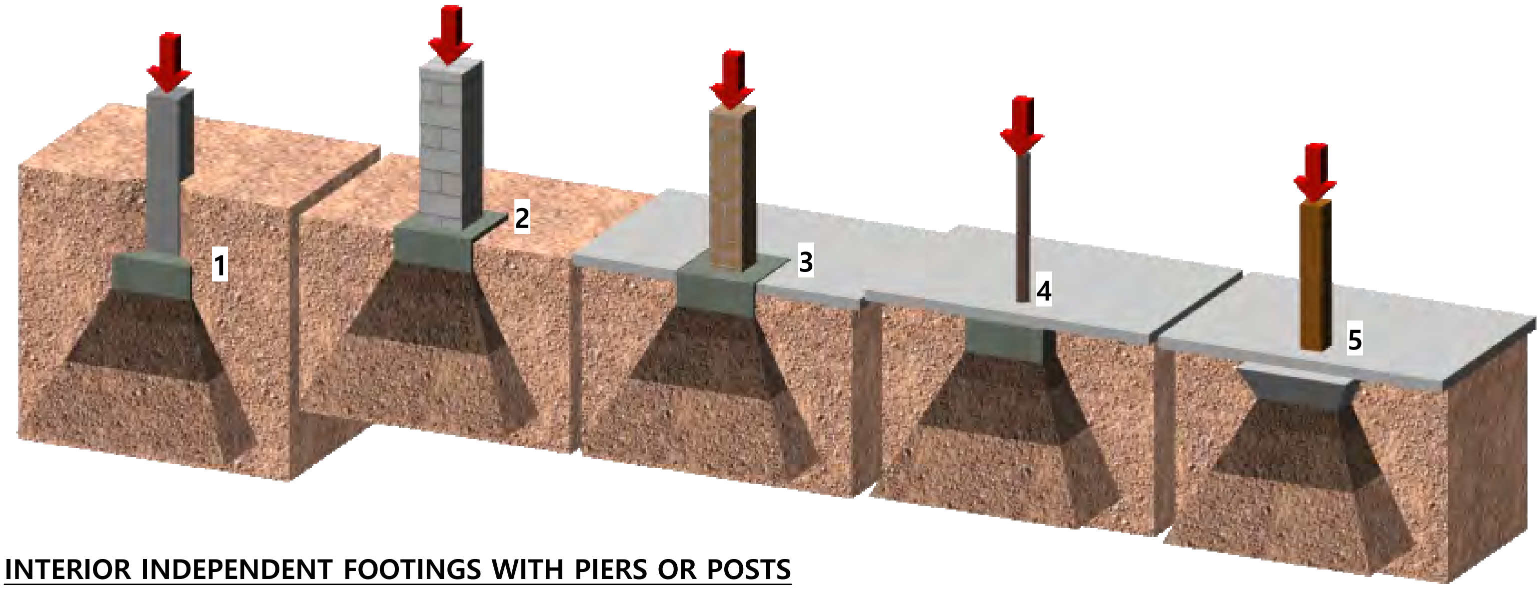
1*THE 2 FUNCTIONS OF THE STAND OFF ANCHOR_A VARIETY OF DESIGNS EXIST TO CONNECT A WOOD POST TO A CONCRETE FOOTING. THESE ANCHORS KEEP THE WOOD OFF THE THE CONCRETE (OFFSET) SO WATER IS DISCOURAGED FROM ENTERING THE END GRAIN OF THE POST. THE ANCHOR IS EMBEDDED IN THE CONCRETE EITHER WHEN THE CONCRETE IS POURED OR AFTER USING A HAMMER DRILL AND EPOXY. THE STAND OFF ANCHOR IS USUALLY VALUABLE IN EXTERIOR POST REQUIREMENTS LIKE DECKS.

2*REAL BEARING AREA_BACKHOE OR HAND DUG FOOTING HOLES FREQUENTLY RESULT IN A DIFFERENT SQUARE FOOTAGE AT THE BOTTOM FROM THE TOP. THE BEARING AREA IS MEASURED AT THE BOTTOM. THE SIZE AT THE TOP IS LARGELY IRRELAVENT.

3*PUNCH/SHEAR_POST LOADS TEND TO BE 'CONCENTRATED'- A LOT OF LOAD HITTING THE CONCRETE OVER A SMALL AREA. THEORETICALLY A POST COULD 'PUNCH' THRU THE CONCRETE IF IT IS TOO THIN. THIS WOULD BE A SHEAR FAILURE. SHORT OF PUNCHING THRU, THAT LOAD COULD CRACK A FOOTING AND ESSENTIALLY FAIL. THICKER FOOTINGS AND OR BEARING PLATES ILLUSTRATED ABOVE ARE UTILIZED TO AVOID THIS CONDITION.

4*OFFSET LOAD_THIS POSSIBLE ROTATION OR OVERTURNING IS MORE A CONCERN WITH CONCENTRATED POST LOADS NOT PROPERLY CENTERED AS ILLUSTRATED, THAN WITH CONTINUOUS FOOTINGS (c2.8). BOTTOM LINE HERE IS THAT LOADS WANT TO BE CENTERED ON THE FOOTINGS.

5*SLENDER POST_THIS REPRESENTS A POST FAILURE, NOT A FOOTING FAILURE, BUT A STRUCTURAL FAILURE THAT NEEDS TO BE AVOIDED.(c5.16)



INTERIOR INDEPENDENT FOOTINGS WITH PIERS OR POSTS

1*DEEPER FOOTING_MAY BE NEEDED TO GET TO GOOD BEARING SOIL (OBVIOUSLY THE BACKFILL DOES NOT SHOW THIS ILLUSTRATION). OR A SITUATION WHERE FROST DEPTH REMAINS A CONCERN- EVEN WITHIN THE PROJECTED FOOTPRINT. TALL CRAWL SPACES INSULATED AT THE MAIN FLOOR PLANE ABOVE MIGHT BE SUBJECT TO FROST PENETRATING UNDER THE HOUSE IN COLD CLIMATES. NORMALLY A HOUSE GIVES OFF ENOUGH HEAT WHERE SOILS UNDERNEATH ARE NOT SUBJECTG TO FREEZING- BUT...

2*CRAWL SPACE PIER_SHOWING A VERY TYPICAL 2'X2' CONC FOOTING (OR LARGER) WITH 16" SQUARE BLOCK PIER. BASIC AND FLEXIBLE.

3*FLUSH FOOTING__STRUCTURALLY NO DISTINCTION WITH #4. SO THIS DISTINCTION IS MOSTLY A CONSTRUCTION PROCESS AND PREFERENCE DECISION. INSTALLATION SEQUENCE AND TYPE OF POST, AND OR THE CONCRETE SLAB'S PROPOSED EXPANSION/CONTROL JOINTS MIGHT BE IN PLAY.

4*FOOTING BELOW SLAB_SEE ABOVE

5*FOOTING BELOW SLAB_IF FOOTINGS ARE TRENCH POURED, AND A LITTLE RAGGED LOOKING, ONE CAN SET THEM BELOW SLAB SO THE SLAB COVERS UP IRREGULARITIES.

EXTERIOR INDEPENDENT FOOTINGS WITH PIERS OR POSTS

HANDICAP_GETTING BELOW FROST LINE IS A REQUIREMENT AND A DEVIL IN DISGUISE FOR EXTERIOR INDEPENDENT FOOTINGS

1*MASONRY_A VARIETY OF DESIGNS EXIST TO CONNECT A WOOD POST TO A CONCRETE FOOTING. THESE ANCHORS KEEP THE WOOD OFF THE THE CONCRETE (OFFSET) SO WATER IS DISCOURAGED FROM ENTERING THE END GRAIN OF THE POST. THE ANCHOR IS EMBEDDED IN THE CONCRETE EITHER WHEN THE CONCRETE IS POURED OR AFTER USING A HAMMER DRILL AND EPOXY. THE ANCHOR DISTRIBUTES THE LOAD. NOTE THE LOAD DISTRIBUTION IS FROM THE BOLT OR THE ANCHOR'S FLANGES- NOT THE POST SIZE ITSELF.

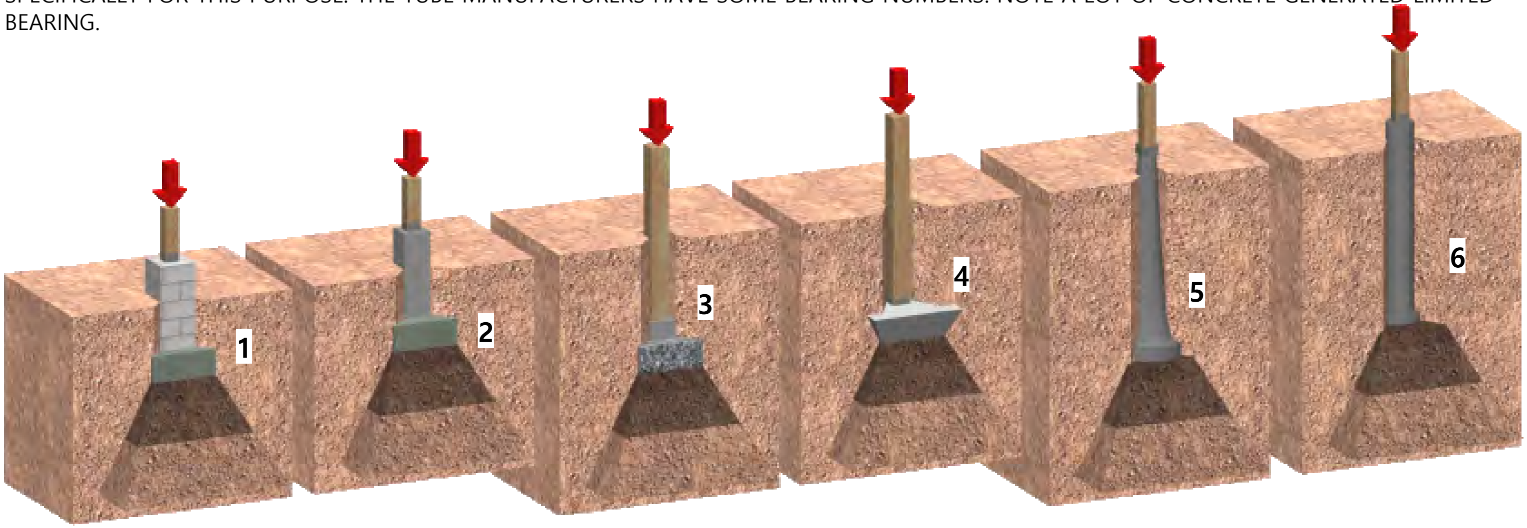
2*MASONRY_DITTO #1 SHOWING FORMED CONCRETE PIER BRINGING THE NON ROT MASONRY CONSTRUCTION ABOVE GRADE.

3*GRAVEL, PREFAB SADDLE, WOOD POST__FILL IN THE BOTTOM OF A MACHINE OR HAND DUG HOLE WITH GRAVEL+COMPACT. SET A PREFAB CONCRETE DECK SHOE ON THE GRAVEL. LOAD DISTRIBUTED FROM POST TO SHOE THRU GRAVEL (60^{O} DISTRIBUTION) TO SOIL. SHOE+POST CAN BE SHIFTED AROUND WHILE PROPERLY POSITIONING FRAMING ABOVE. GRAVEL BACKFILL AFTER FRAMING IS SET+SQUARE. UPLIFT RESISTANCE LIMITED.

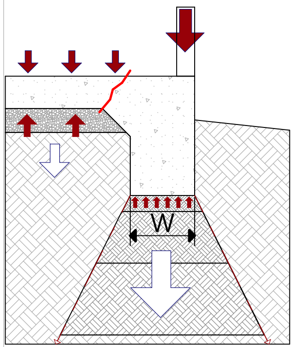
4*CONC HOLE FOOTING,ANCHOR+WOOD POST_FILL IN THE BOTTOM OF A MACHINE OR HAND DUG HOLE WITH CONCRETE. POSITION A STAND OFF ANCHOR. SET A NON ROT POST. RECOMMEND BACKFILL PART WAY TO ALLL THE WAY WITH GRAVEL TO KEEP FOREVER WET SOIL AWAY FROM POST . THINK TWICE BEFORE SUPORTING A ROOF WITH THIS ROT SUSCEPTIBLE TECHNIQUE.

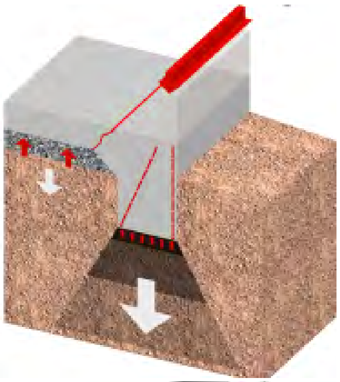
5*PREFAB BELL FOOTING+PIER_THE DIAMETER OF THE BELL FOOTING DETERMINES LOAD CAPACITY, AND THERFORE THE SIZE OF THE HOLE. THERFORE AUGER OR BIG BACKHOE HOLE AS REQUIRED. DROP, LEVEL, POSITION, BACKFILL. FAST BUT NOT LOCATION FORGIVING.

6*ROUND CONCRETE PIER_THE APPEAL OF THIS FOOTING IS GETTING BELOW FROST BY DRILLING A HOLE (WITH HAND OR MACHINE AUGER). SOIL PERMITTING IT IS CLEAN AND FAST. CONCRETE CAN BE POURED DIRECTLY IN A CLEAN HOLE, OR INSIDE A CARDBOARD TUBE DESIGNED SPECIFICALLY FOR THIS PURPOSE. THE TUBE MANUFACTURERS HAVE SOME BEARING NUMBERS. NOTE A LOT OF CONCRETE GENERATED LIMITED BEARING.

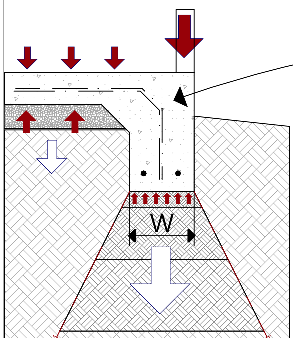


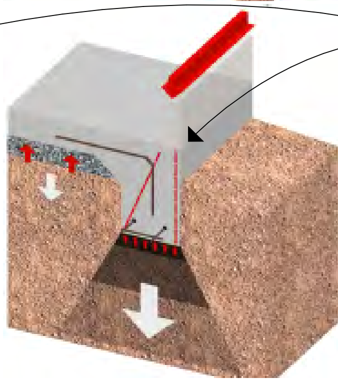
FTG+FDN PROFILES- SLAB ON GRADE WITH INTEGRAL FOOTING





PLAIN CONCRETE



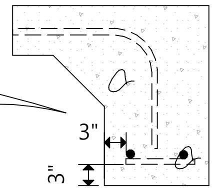


REINFORCED CONCRETE

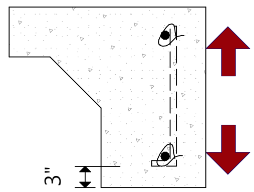
PERIMETER INTEGRAL FOOTINGS/FOUNDATION

***'W'**_FOOTING WIDTH MATH IS THE SAME AS WITH ANY FOOTING. ADD UP THE LOADS AND DIVIDE BY THE SOIL BEARING VALUE AND THE 'W' IS THE RESULT. THE LOADING IS COMING FROM THE MAIN LEVEL PERIMETER BEARING WALL. THE OUTSIDE FACE OF THAT WALL IS ALMOST ALWAYS FLUSH WITH THE OUTSIDE FACE OF THE FOOTING/FOUNDATION PLANE. IN THEORY THEN SOME ROTATION IS POSSIBLE. BUT THE FOOTING AND SLAB IS ONE ENTITY SO ROTATION IS CHECKED. NOTE 'W' IS TYPICALLY A MINIMUM OF 12" PER CODE.

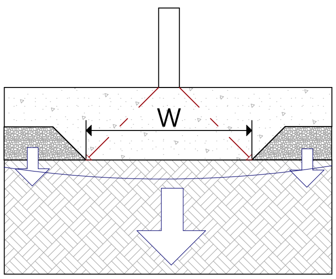
***REINFORCEMENT**_CHECK CODE, LOCAL PRACTICE. IRC REQUIRES REINFORCEMNT IN SEISMIC DESIGN CATEGORIES D_0,D_1,D_2.

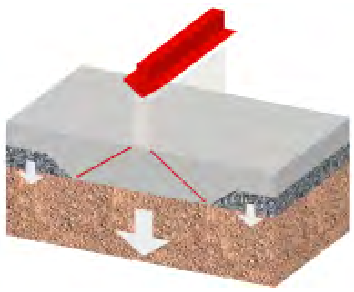


REINFORCEMENT
*Continuous perimeter reinforcement at bottom is having the footing function as a grade beam. Min conc cover of 3" typical.
*Bent rebar tieing footing and slab keeps that 90⁰ turn in the concrete pour out of harms way.

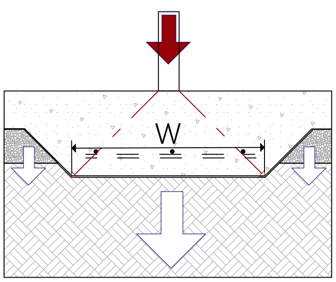


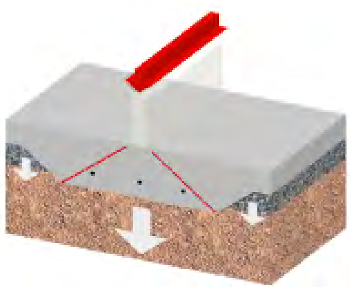
SEISMIC REINFORCEMENT
*Positioning of reinforcemnt in seismic is different because one is protecting both vertical gravity loads and vertical upward acting (shaking of the earth) loading. A few choices are noted in the code. This is one.





PLAIN CONCRETE



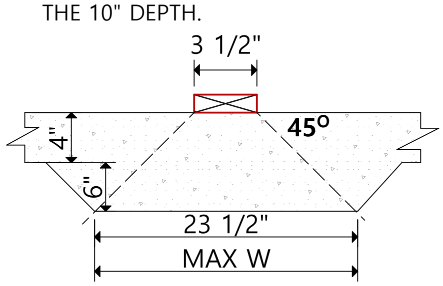


REINFORCED CONCRETE

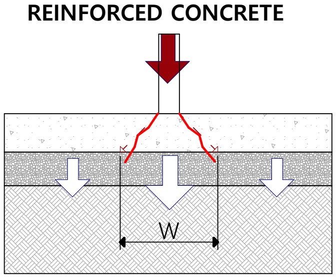
THICKENED SLABS aka HAUNCH SLAB aka INTERNAL FOOTINGS

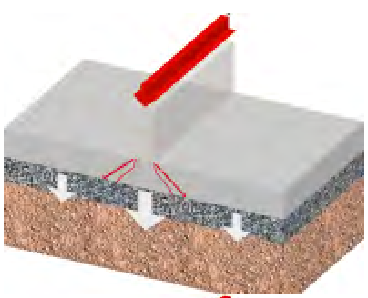
***DISTRIBUTION**_THE THICKENED SLAB UNDER BEARING LOADS IS STANDARD STUFF. FOLLOWING THE 45^{O} DISTRIBUTION RULE THE DEPTH OF THE THICKENED SLAB CONTROLS THE 'W' REQUIRED FOR BEARING. COMMON IS A 6" INCREASE IN SLAB DEPTH, THEREFORE A TOTAL DEPTH AT THE BEARING LINE OF 10". A 3 1/2" WIDE 2X4 WALL THEN ACHIEVES A BEARING WIDTH OF 23 1/2" OR 4000 PLF CAPACITY (INCLUDING DEAD LOAD OF CONCRETE) ASSUMING 2000 PSF SOIL CAPACITY.

***OPTIONAL REINFORCEMENT**_PERFORMS THE SAME FUNCTION. BRIDGING SOFTER SOILS AND MAKING POSSIBLE THE INCREASE OF 'W' MAINTAINING THE 10" DEPTH.

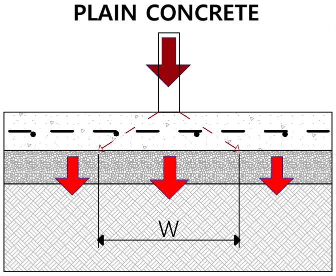


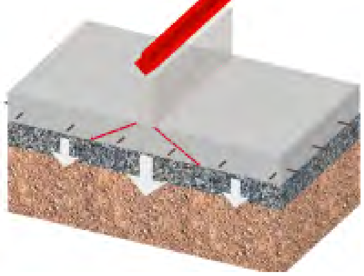
TYPICAL THICKENED SLAB
*Loads are usually less than the sample 4000 plf noted above.
*Thickened slab widths may be noted/required as 8",12",16, referencing the 'w' dimension at the bottom.
*The trench required for the thickened slab may be dug, or may be created by controlling the gravel sub base.





PLAIN CONCRETE





REINFORCED CONCRETE

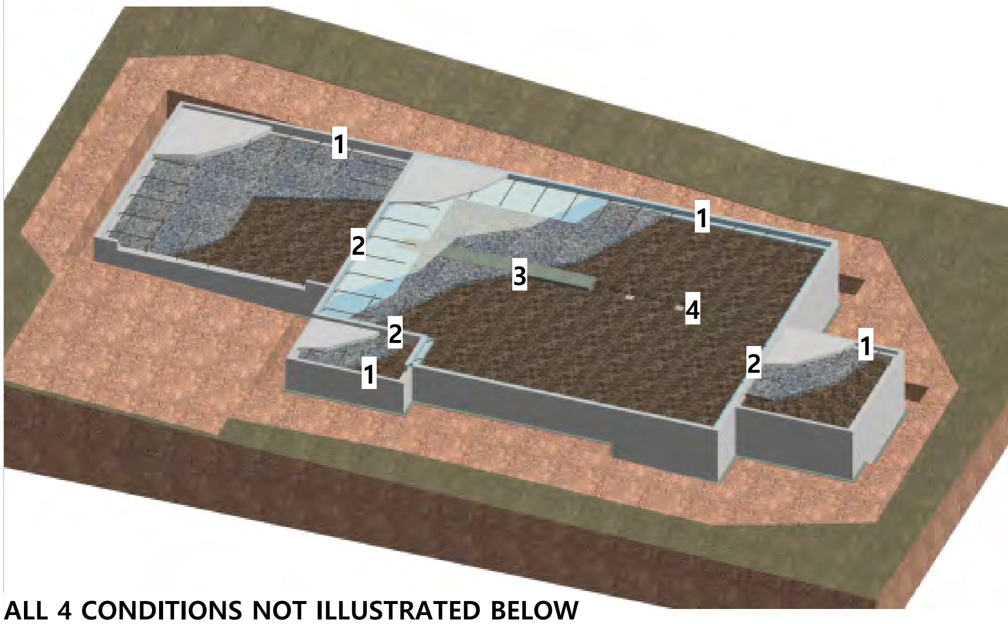
LOADING ON SLAB FLOORS

***NON BEARING/LIGHT BEARING WALLS**_ARE FINE ON NON-REINFORCED SLABS. WHEN LOADING GETS TOO MUCH THOSE SHEAR CRACKS ARE LIKELY TO SHOW UP SUGGESTING SETTLEMENT GOING ON.

***THE REINFORCED SLAB**_INCREASES THE LOAD POTENTIAL FOR BEARING WALLS ON THE SLAB. THAT REINFORCEMENT WOULD BE STRUCTURAL REINFORCEMENT USING #3, OR #4 REBAR IN A GRID. FIBER AND WELDED WIRE MESH HAVE A SHRINKAGE AND CRACKING CONTROL ROLE BUT WOULD NOT BE CONSIDERED 'STRUCTURAL' REINFORCEMENT ALLOWING MORE LOAD. BECAUSE IT IS MORE COST EFFECTIVE TO MANAGE

***HOW MUCH LOAD**_USING OUR SAME 45° DISTRIBUTION AND A 2X4 CARRYING THE LOAD, A NON-REINFORCED 4" SLAB SHOULD BE CAPABLE OF 1280 PLF BASED ON A 'W' OF 11.5". THE ENGINEERING WORLD COMPLICATES THIS BY ADDING A 'SOIL FLEX FACTOR' INTO THE FORMULA WHICH REDUCES THAT CAPACITY A BUNCH. THE BOTTOM LINE IS THAT MOST INSPECTORS WILL WANT TO SEE A HAUNCHED SLAB UNDER ANY PARTITIONS THAT ARE BEARING, OR WANT SPECIFIC VERIFICATION THAT A HAUNCH IS NOT REQUIRED.

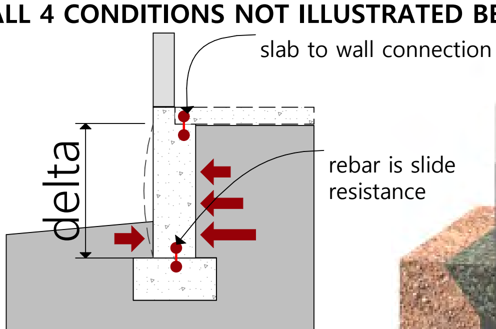
FTG+FDN PROFILES- STEM WALL FOUNDATION



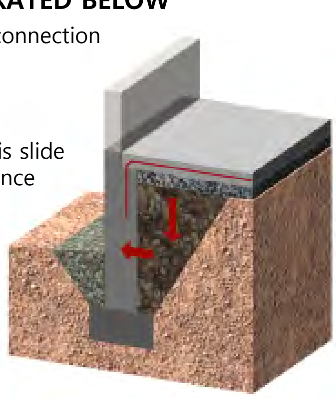
INSIDE OUT

1*CONSISTENT EXTERIOR CONDITION_THE FOUNDATION WALL STEM WALL IS A CONTAINER FOR FILL WHICH NEEDS TO BE COMPACTED TO OUR BEARING CAPACITY STANDARD. THE COMPACTING PROCEDURE IS NECESSARILY DONE BEFORE THE SLAB IS INSTALLED WHICH EXERTS A DYNAMIC PRESSURE ON THE WALLS. THE WALLS NEED TO WITHSTAND BOTH THE TEMPORARY COMPACTION PROCEDURE, AND THE LONG TERM PRESSURE THAT NEVER GOES AWAY.
2*FILL TO FILL CONDITION_THE DIFFERENTIAL FILL CHANGES AROUND THE PERIMETER. HEIGHT OF THE DIFFERENTIAL FILL AND FILL VOLUME DIRECT THE WALL DESIGN.
3*INTERIOR THICKENED SLAB_SUPPORTING CENTER BEARING REQIUIREMENT. FOR HOUSE ABOVE NOT SHOWN,₩.
4*GRADE BEAM OR INTERIOR SUPPORT WALL OR BOTH_SUPPORTING CENTER BEARING REQUIREMENT OVER DEEP FILL.

ALL 4 CONDITIONS NOT ILLUSTRATED BELOW

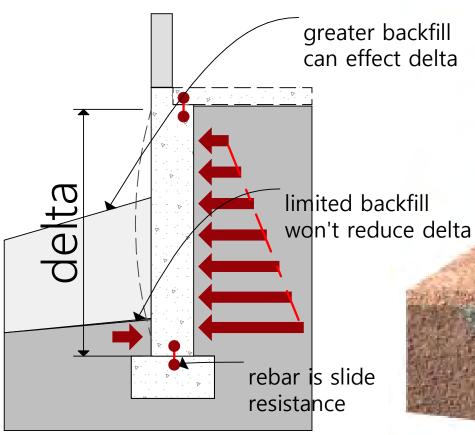


STEM WALL FOUNDATION SYSTEM

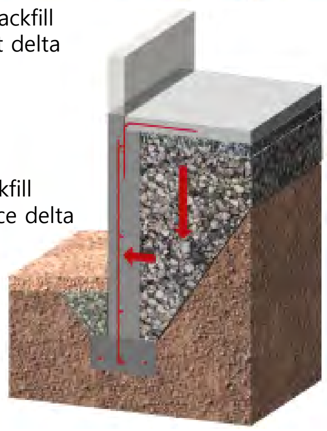


1 LIMITED DIFFERENTIAL FILL

***PRESSURE FROM THE INSIDE**_TYPICAL THIS STEM WALL SYSTEM IS SOIL (FILL) PRESSURE FROM INSIDE OUT. THE 'DELTA' IS THE DIFFERENTIAL FILL WHICH IS THE THE SIGNIFICANT WALL DESIGN CRITERION. THE GREATER THE DELTA THE GREATER THE FILL PRESSURE.
***PERIMETER 'SLIDE' POTENTIAL AT FOOTING** TIEING FOOTING TO STEM WALL WITH REINFORCMENT TO ELIMINATE 'SLIDING' IS SMART.
***BALANCING THE FILL DIFFERENTIAL**_A LITTLE LOOSE BACKFILL ON THE OUTSIDE WILL NOT EFFECT THE 'DELTA' DIFFERENTIAL FILL DESIGN CRITERION. A LOT OF BACKFILL WILL AND CAN CHANGE THE DELTA DIMENSION.
***SLAB TIE**_REINFORCEMENT CONNECTION BETWEEN WALL AND SLAB IS WISE AND IMPORTANT. THIS INSURES STABILITY AT THIS LOCATION WHERE FILL IS ALWAYS REQUIRED/PRESENT.

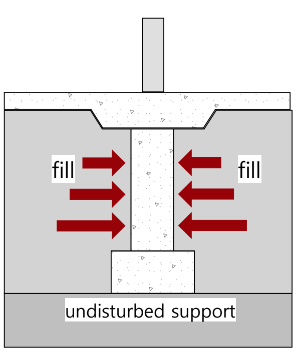


STEM WALL FOUNDATION SYSTEM

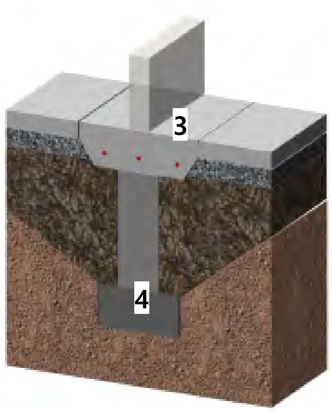


1 GREATER DIFFERENTIAL FILL

***DITTO**_TO ALL COMMENTS ABOVE. THE DIFFERENCE THIS CONDITION IS THE 'DELTA' DIFFERENTIAL FILL IS GREATER THEREBY UNDER GREATER PRESSURE REQUIRING A MORE ROBUST WALL.
***WALL DESIGN**_BOTH BACKFILLING PRESSURE AND LONG TERM LATERAL PRESSURE IS SIMPLY INCREASED WITH INCREASED HT AND FILL VOLUME. REINFORCEMENT AS REQUIRED IN THE WALL WOULD WANT TO BE TOWARD THE OUTSIDE AS THAT SIDE OF THE WALL IS IN TENSION.
*****BACKFILLING**_THIS ADDITIONAL PRESSURE PUSHING A WALL OUT DURING THE BACKFILL PROCEDURE IS A REAL CONCERN. A LOT OF WALLS-PARTICULARLY CONCRTE BLOCK WALLS- CAN SIMPLY BE BLOWN OUT. CAREFUL BACKFILLING REQUIRED. SURCHARGING THE OUTSIDE THRU CONSTRUCTION IS ANOTHER OPTION.

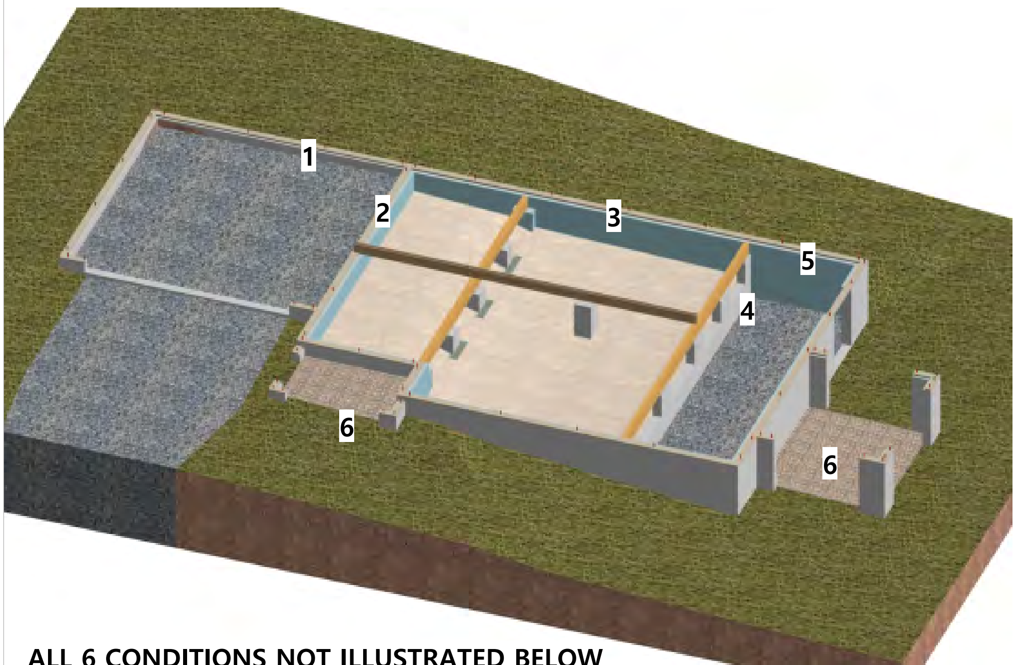


CENTER SUPPORT CONDITION



3 4 INTERNAL SUPPORT

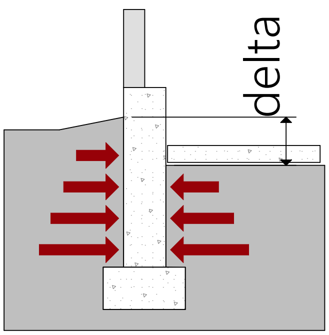
***2 CONDITIONS**_THE IMAGE OF THE WHOLE FOUNDATION IS SUGGESTING 2 INTERNAL CONDITIONS WHERE THE CENTER BEARING OCCURS IN THE MIDDLE OF THE HOUSE. ONE IS A THICKENED SLAB SUPPORT. THE OTHER SHOWS PIERS WITH FOOTINGS BELOW ON UNDISTURBED EARTH, IF THIS ENTIRE AREA WERE PROPERLY FILLED/COMPACTED THERE WOULD BE ONLY 1 CONDITION, BUT SHORT CUTS WITH FILL AND COMPACTION ARE COMMON.
***PIERS WITH GRADE BEAM CENTER SUPPORT**_WITH PROPER REINFORCEMENT AND A MIN DEPTH OF 10" THE THICKENED SLAB CAN SPAN PIER TO PIER AND ACT AS A GRADE BEAM. THIS IS AN ENGINEERED SITUATION. SOIL CONDITION, SPAN, REINFORCEMENT, GRADE BEAM DEPTH ALL NEED CONSIDERATION.
***OR AN INTERNAL CONTINOUS SUPPORT WALL**_WITH CONTINOUS FOOTING AT UNDISTURBED EARTH IS ESSENTIALLY RISK FREE.



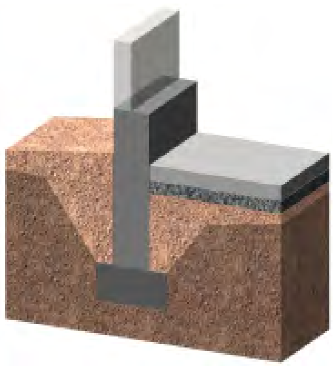
SEVERAL CONDITIONS

1*GARAGE TO GRADE_THIS CONSTRUCTION CONDITION PRETTY TYPICAL OF ALL FOUNDATION SYYSTEMS**.**
2*GARAGE TO CRAWL_LOW WALL, LIMITED DELTA THIS EXAMPLE. REMINDER THAT GARAGE SUBGRADE MAY NEED COMPACTION.
3*CRAWL TO GRADE_SUBJECT TO GRADE HEIGHT. STEPPED FOOTINGS (AND WALL) TYPICAL THIS SITUATION. CHANGES AS GRADE CHANGES.
4*CRAWL TO STORAGE CRAWL_ANOTHER GRADE DIFFERENTIAL VARIATION REQUIRING A WALL THAT HAS BOTH A RETAINING AND STRUCTURAL SUPPORT FUNCTION.
5*STORAGE CRAWL TO GRADE_LITTLE GRADE DIFFERENTIAL INSIDE TO OUTSIDE SO THESE WALLS MOSTLY HANDING GRAVITY LOADS.
6*PORCHES_POST+BEAM_AS SHOWN THESE ARE POSTS (MASONRY VERTICAL SUPPORTS) WITH BEAMS AND JOISTS (NOT SHOWN).

ALL 6 CONDITIONS NOT ILLUSTRATED BELOW

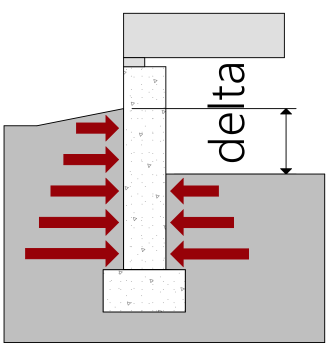


GARAGE

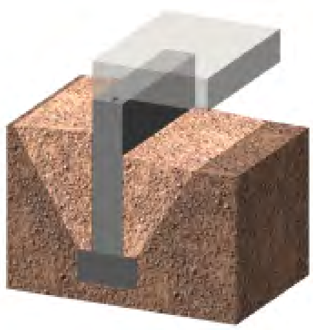


1 GARAGE FOUNDATION WALLS

***STANDARD STUFF**_THE FOUNDATION WALL HT IS SUBJECT TO OPTIONS BASED ON GRADE CONDITIONS OR CONSTRUCTION PREFERENCES. (c1.12,c1.13,c1.14)
***CHANGING SYSTEMS**_IN A MINIMAL FROST DEPTH SITUATION CHANGING THIS GARAGE SUPPORT SYSTEM TO AN INTEGRAL FOOTING IS CERTAINLY OK. NOT SHOWN.

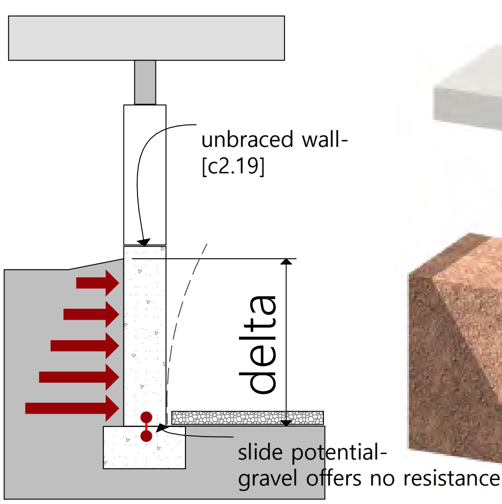


CRAWL SPACE

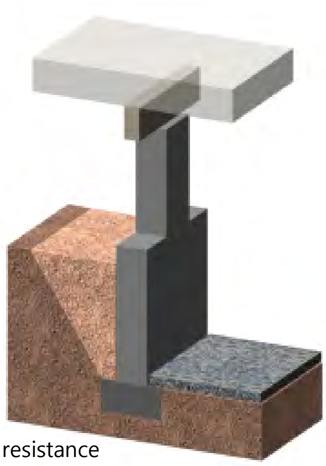


3 CRAWL SPACE TYPICAL

***UNIVERSAL SECTION**_GRADE ON EITHER SIDE OF THE WALL CAN DIFFER BUT THE CONSTRUCTION REMAINS BASICALLY THE SAME
***BACKFILLING**_THIS SECTION IS A GOOD ONE TO COMMENT THAT BACKFILL ON EITHER/BOTH SIDES HAS LITTLE STRUCTURAL FUNCTION AND (BY CODE) NOT EVEN A DRAINAGE ONE AS FOUNDATIONS DRAINS MAY NOT BE REQUIRED WITH NO LIVING SPACE THIS LEVEL. SO BACKFILL MATERIAL SELECTION IS NOT SO IMPORTANT. ANOTHER UNIVERSAL COMMENT IS THAT BACKFILLING EQUALLY, ONE SIDE/THEN THE OTHER SIDE, INCREMENT BY INCREMENT, KEEPS PRESSURE CONSISTANT ON BOTH SIDES AND AVOIDS ANY WALL BLOWOUT POTENTIAL.



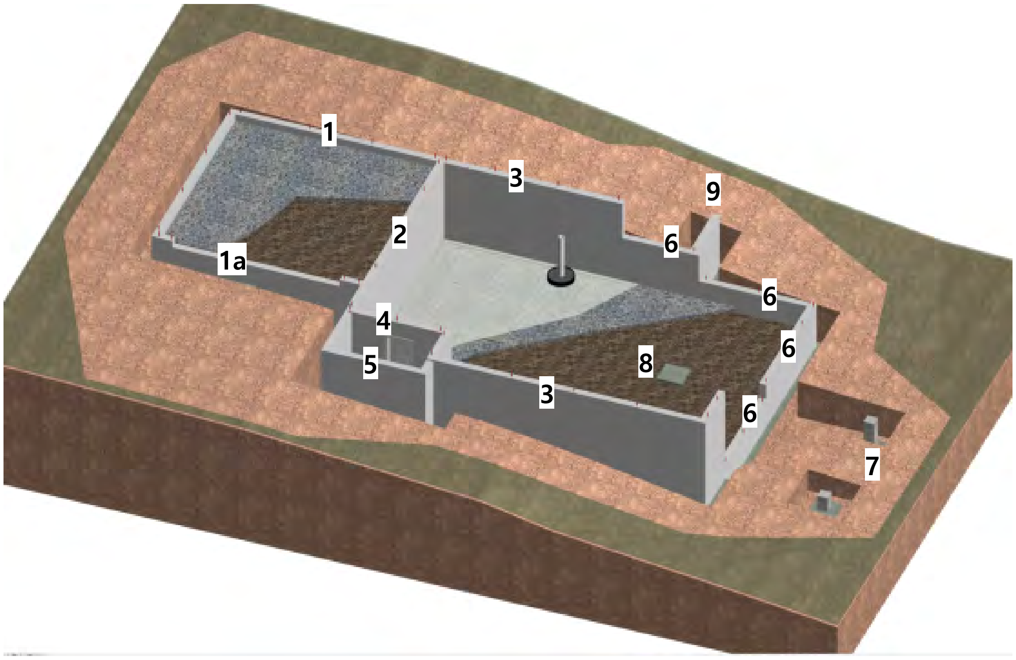
CRAWL INTERNAL RETAINING WALL



4 CRAWL SPACE INTERNAL BEARING WALL

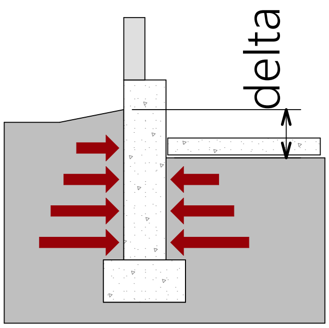
***2 FUNCTIONS**_THIS IS A GRAVITY LOAD BEARING WALL AND A RETAINING WALL. RETAINING WALLS ARE SO NAMED WHEN THEY ARE NOT FULLY BRACED AT THE TOP.(c2.19). SHOWN ARE MASONRY POSTS SUPPORTING THE BEAM ABOVE. WOOD POSTS OR 2X4 OR 2X6 SECTIONS OF SUPPORT WALL ARE SUBSTITUTES. OPEN ACCESS TO THE HIGHER CRAWL USUALLY DESIREABLE.
***FLOOR**_GRAVEL ON THE STORAGE FLOOR IS A CONVENIENCE. A SLAB IS ALWAYS AN OPTION.
***SEALED OR CLOSED CRAWL**_ ARE NOT SHOWN THESE STRUCTURAL SECTIONS BUT OFTEN RECOMMENDED

FTG+FDN PROFILES- BASEMENT FOUNDATION 1



SEVERAL CONDITIONS

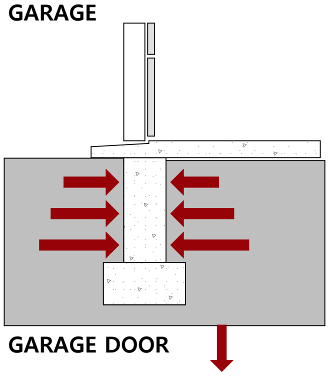
1*GARAGE TO GRADE_TYPICAL ALL GARAGE TO GRADE CONDITIONS
2*GARAGE TO HOUSE_USUALLY A HGHER FILL DIFFERENTIAL BASED ON THE GARAGE FLOOR ELEVATION
3HOUSE TO GRADE**_SEVERAL CONDITIONS AROUND THE PERIMETER
4*HOUSE TO PORCH_BASED ON PORCH FLOOR DECISION. SEE PORCH CONDITION 1,2 (c2.15)
5*PORCH TO GRADE_BASED ON PORCH FLOOR DECISION. SEE PORCH CONDITION 1,2 (c2.15)
6*HYBRID WALLS_PARTIAL HT MASONRY, PARTIAL HT FRAME WALLS TYPICAL IN DAYLIGHT AND WALKOUT BASEMENTS
7*POST AND BEAM PORCH_HIGHER OFF THE GROUND MAIN LEVEL PORCH FLOOR SUPPORTED WITH POST AND BEAM RESTING ON MASONRY PIERS AND CONCRETE FOOTINGS
8*INTERNAL FOOTINGS AND POSTS_CENTER BEARING BEAM REQUIRES POSTS AND POST FOOTINGS AT OR BELOW BASEMENT SLAB
9*RETAINING_EXTENSION OF THE FOUNDATION CONSTRUCTION SHOWS AND MANAGES GRADE SO WINDOW SILL HTS CAN BE ACHIEVED IN BASEMENT WALL (4)



GARAGE

1 **GARAGE FOUNDATION WALLS**

***STANDARD STUFF**_THE FOUNDATION WALL HT IS SUBJECT TO OPTIONS BASED ON GRADE CONDITIONS OR CONSTRUCTION PREFERENCES. (c1.12,c1.13,c1.14)

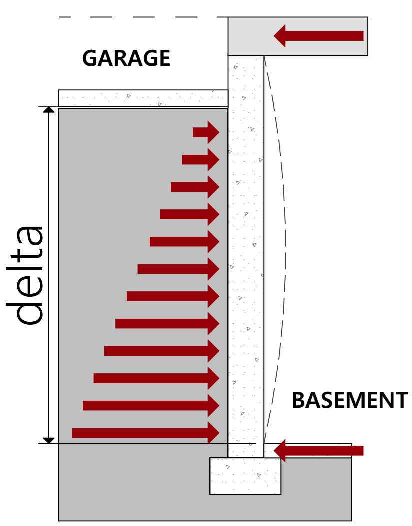


GARAGE DOOR

GARAGE FOUNDATION WALL AT GARAGE DOOR

1a ***WITH FOUNDATION WALL**_RUNNING THE FOUNDATION SYSTEM AND INSTALLING DRAINAGE UNDER THE GARAGE DOOR IS SHOWN. DRAINAGE CAN BE A BIG DEAL HERE. THE FOUNDATION WALL IS TYPICALLY DROPPED TO REST THE SLAB ON. THIS SLAB SHOWS A CONCRETE APRON EXTENDING OUT TO THE DRIVEWAY AREA. APRONS ARE GOOD AND WANT SUPPORT AS DOES THIS WHOLE DRIVEWAY OUTSIDE THE FOUNDATION WALL. SETTLEMENT HERE BECOMES A PROBLEM.

***WITHOUT FOUNDATION WALL**_FOOTINGS AND FOUNDATION WALL ARE NOT ALWAYS INSTALED UNDER GARAGE DOORS. THERE IS NO GRAVITY LOADING ON THE SLAB THERE AS LOADING ABOVE IS DIVERTED WITH THE GARAGE DOOR HEADER. THERE IS FROST HEAVE POTENTIAL HOWEVER. SOMETIMES THIS PRACTICE MAY BE REGIONAL.

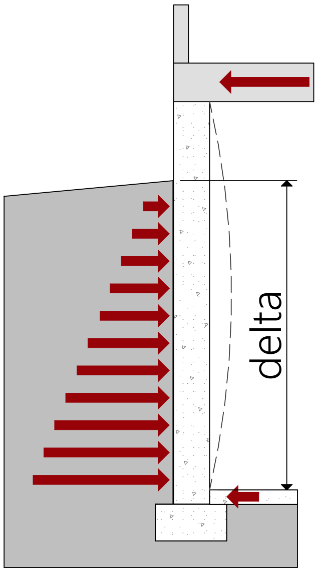


GARAGE TO HOUSE FULL BASEMENT

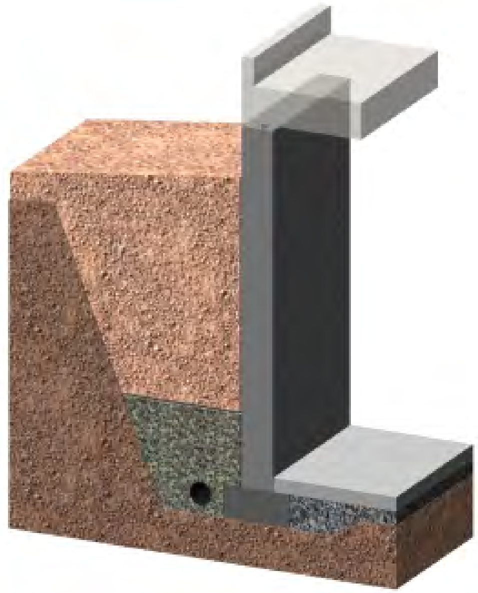
BASEMENT WALL AT GARAGE

2 ***BIG DELTA**_WITH A FULL BASEMENT CEILING HT AND A GARAGE FLOOR THAT WANTS TO MINIMIZE STEPS INTO THE HOUSE, THS BASEMENT WALL IS OFTEN THE ONE DEALING WITH THE BIGGEST DELTA AND SOIL (FILL) LOAD. THIS GARAGE FLOOR WANTS A FIRM COMPACTED SUB BASE AND COMPACTED FILL AS WELL. SOME BUILDERS MAY ELECT TO PUT SOME SUPPORT PIERS IN THE 'MIDDLE' OF THE GARAGE FLOOR AREA AND POUR A 2 WAY STUCTURAL GARAGE SLAB FLOOR TO ELIMINATE ALL THE COMPACTION AND REDUCE PRESSURE ON THE BASEMENT WALL.

***BACKFILLING**_IT IS BEST IF BOTH BASEMENT SLAB AND MAIN FLOOR DECK ARE IN PLACE AS BACKFILL BRACES. ADDITIONALLY IN THIS SCENARIO TEMPORARY BRACING CAN BE IN INSTALLED FROM BASEMENT SLAB TO BASEMENT WALL WHILE GARAGE BACKFILLING PROCEDURE IS IN PROGRESS. MASONRY WALLS-CONCRETE PARTICULARLY-HAVE A GREEN (WET) PERIOD BEFORE THEY CURE AND ARE SUBJECT TO BOWING/BULGING FROM SOIL PRESSURE. BRACING WILL CONTROL THAT.



FULL BASEMENT



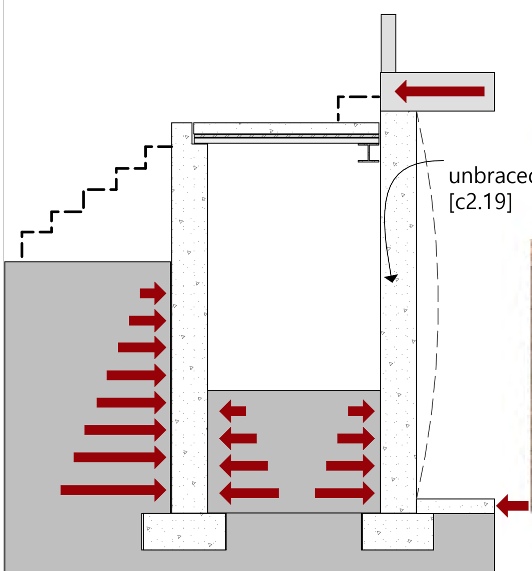
3 **FULL HT BASEMENT WALL**

1*VERTICAL BEAM_(c2.2) THIS FULL BASEMENT WALL IS THE CLEANEST CONDITION REPRESENTING THE FOUNDATION WALL FUNCTIONING AS A VERTICAL BEAM. IT IS THIS CONDITION THAT THE CODE CHARTS PRIMARILY ADDRESS (c2.17)

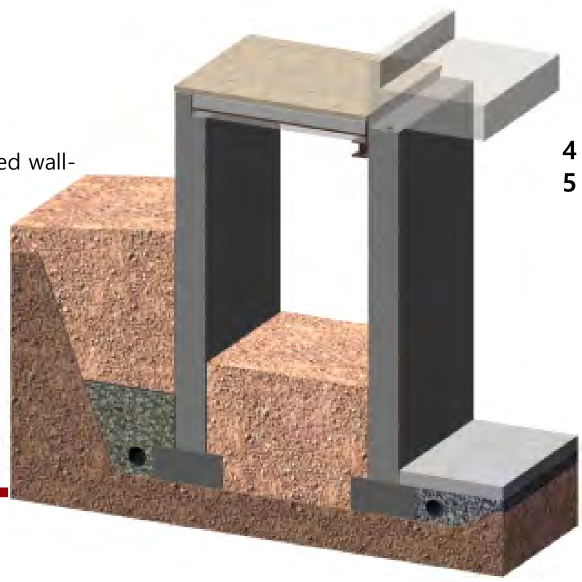
2*3 DESIGN FACTORS_THE BEAM SPAN IS THE HEIGHT OF THE WALL FROM "SUPPORT TO SUPPORT", OR FROM TOP OF SLAB TO THE TOP OF WALL. THE BASE HORIZONTAL SOIL LOAD IS THE HEIGHT OF THE SOIL ON THE OUTSIDE OF THE FOUNDATION WALL- WHICH IS THE DELTA OR DIFFERENTIAL FILL HT. THE SOIL LOAD NEEDS TO BE FURTHER QUALIFIED BY IDENTIFYING THE SOIL TYPE AND THERBY THE SOIL PRESSURE CLASSIFICATION.

3*THICKENED SLABS ARE THE INTERNALFOOTINGS_INTERNAL FOOTINGS
MAY OR MAY NOT BE REQUIRED DEPENDING ON THE INTERNAL FLOOR(S) AND ROOF FRAMING AND HOW LOADING IS DISTRIBUTED.

4*NON BEARING PARTITIONS_INTERNAL NON BEARING PARTITIONS AND OTHER INCIDENTAL LOADING ARE SUPPORTED QUITE ADEQUATELY ON THE SLAB ALONE.



FRONT PORCH CONDITION 1



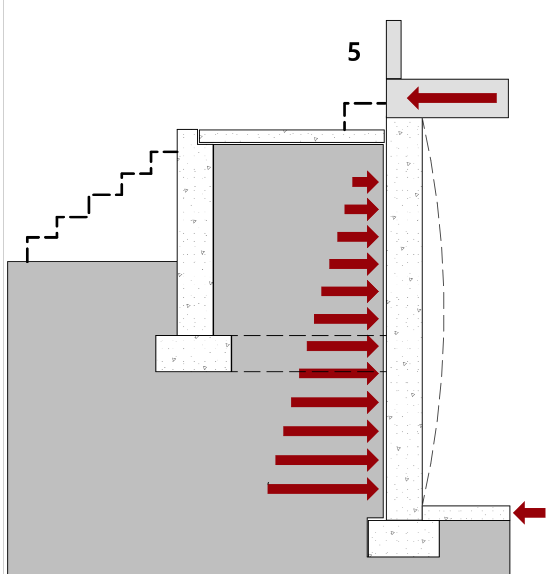
PORCH CONDITION 1

***CONDITION**_A SHORT PORCH IS NEXT TO A FULL HT BASEMENT WALL WANTING A FULL PERIMETER PORCH WALL.
4
5 ***FOUNDATION**_CONTINUES AT THE SAME HT/ELEVATION DEFINING THE PORCH BOUNDARY.

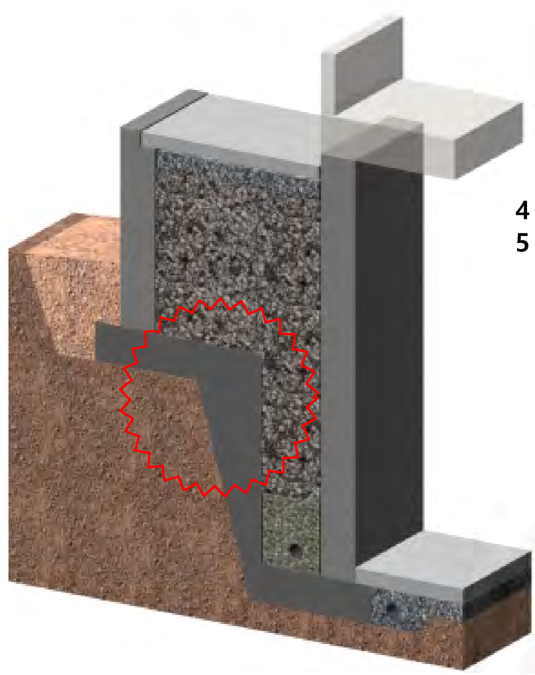
***DECK**_STEEL AND CONCRETE (SHOWN) OR A WOOD DECK SPANS FROM BASEMENT WALL TO PORCH FOUNDATION WALL.

***BACKFILL**_IS 'MODERATED' TO LIMIT SOIL PRESSURE ON BASEMENT AND PORCH FOUNDATION WALLS.

***INCONVENIENCES**_THIS SPACE UNDER THE PORCH MAY REQUIRE ACCESS FROM INSIDE OR OUTSIDE, AND WILL LIKELY NEED VENTILATION AS THIS CONDITION IS A CONDENSATION DEN.



FRONT PORCH CONDITION 2

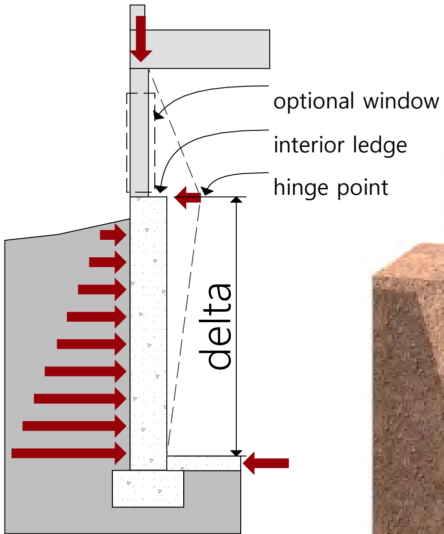


PORCH CONDITION 2

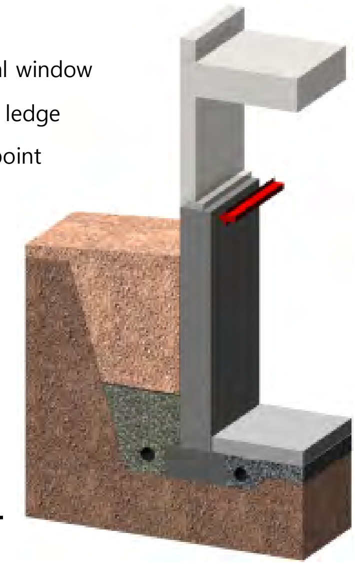
***CONDITION**_A SHORT PORCH IS NEXT TO A FULL HT BASEMENT WALL WANTING A
4 FULL PERIMETER PORCH WALL.
5 ***FOUNDATION**_STEPS UP AS IS POSSIBLE TO LIMIT OVER EXCAVATION AND FOUNDATION PORCH WALLS TALLLER THAN NECESSARY.

***BACKFILL**_THIS CONDITION AS SHOWN IS FULLY BACKFILLED ALLOWING A SLAB ON GRADE PORCH FLOOR

***INCONVENIENCES**_STEPPING FOOTINGS OVER THIS SHORT DEPTH DISTANCE IS TOUGH. THE STRUCTURED STEP HIGHLIGHTED IS SHOWING THE VULNERABLE SPOT. ALSO NOTE THE BASEMENT FOUNDATION DRAIN THAT WANTS TO CONTINUEUNDER THE PORCH AT ITS CORRECT ELEVATION.



DAYLIGHT BASEMENT



6

HYBRID BASEMENT WALL

***CONFIGURATION**_MASONRY CONCRUCTION FROM FOOTING UP AND OUT OF GRADE. 2X6 FRAME WALL PLATE ANCHORED TO THE MASONRY CONSTUCTION WITH 2X6 FRAME WALL ABOVE UP TO MAIN LEVEL FLOOR DECK.

***HINGE POINT**_SOIL PRESSURE SIMILARLY WANTS TO PUSH THE WALL IN, AND TURN THE WALL OVER. FROM A WALL CONSTRUCTION STANDPOINT, THIS IS DISTINCT FROM THE FULL BASEMENT WALL WHICH IS 'FIXED' TOP AND BOTTOM, WITH THE SINGLE CONSTRUCTION WALL ACTING AS THE BEAM. IN THIS CONSTRUCTION A WEAKENED CONDITION EXISTS IN THE WALL WHERE THE FRAMING MEETS THE MASONRY. WHEN PUSHED FROM THE OUTSIDE THIS CONDITION WANTS TO BUCKLE IN. SOMETIMES REFERRED TO AS A 'HINGE'.

**TIEING FOOTING OR SLAB UP INTO THE FOUNDATION WALL WITH REINFORCING INCREASES RESISTANCE TO THE OVERTURNING

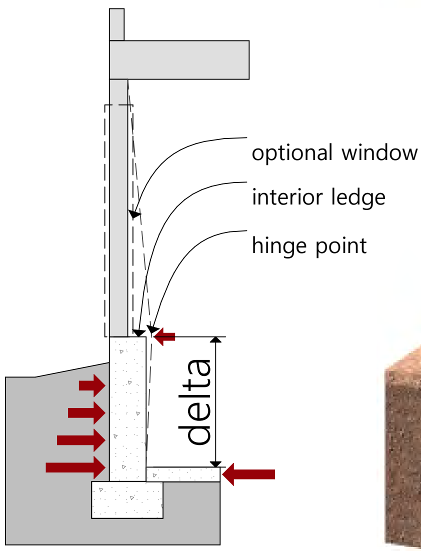
***THE BOTTOM**_A SLAB IS TYPICALLY PRESENT HERE AND OFFERING FULL SLIDE RESISTANCE.

***THE TOP**_THE GRAVITY LOAD OF THE HOUSE IS CARRIED TO THE MASONRY FOUNDATION WALL. THAT LOAD ACTS AS A STABILIZING FORCE.

***THE DIFFERENTIAL FILL**_PRECAUTIONS RELATIVE TO THIS HINGE POINT CONCERN ARE TOTALLY CONTINGENT ON THE SOIL PRESSURE LOAD. IN MANY/MOST INSTANCES THAT DIFFERENTIAL FILL CAN BE UP TO 4' WITHOUT CHANGING ANY FOUNDATION THINKING. IF A WALL IS BEING 'OVERBUILT' (ANYWAY) THAT DIFFERENTIAL FILL MAY BE GREATER WITHOUT ANY ALTERATIONS BEING MADE. BACKFILLING WITH GRAVEL ALONG WITH A DRAINAGE SYSTEM REDUCES/MANAGES LATERAL LOAD. SITUATION STILL WANTS TO BE EXAMINED.

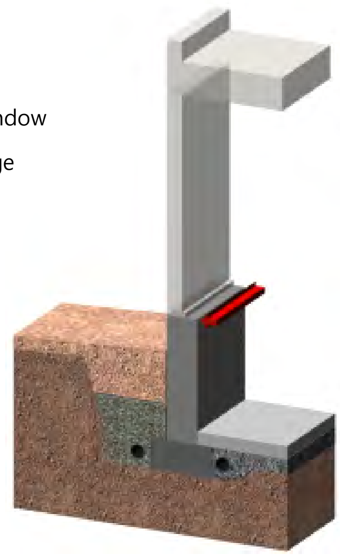
***PRINCIPLES**_SEE APPROACHES TO STRENGTHENING THIS PARTIAL HEIGHT FOUNDATION WALL (c2.19).

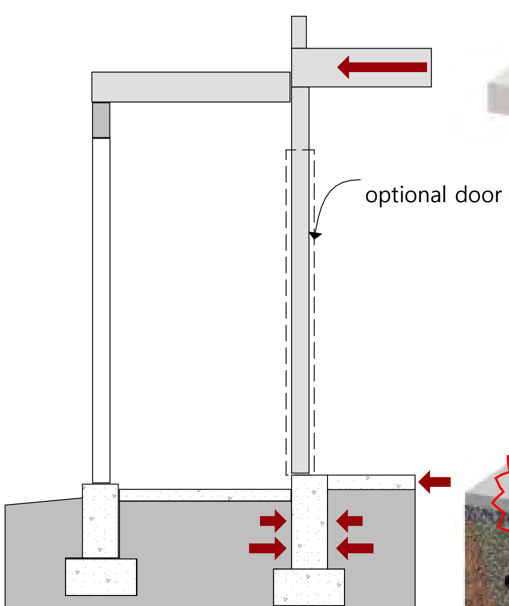
****SUBJECTIVE NOTE ON THIS CONDITION**_A COMPELLING REASON TO STEP THESE FOUNDATION WALLS DOWN IN A DAYLIGHT BASEMENT SITUATION IS FOR WINDOW PLACEMENT, WHICH HAS BEEN NOTED IS A MORE FORGIVING TASK IN A FRAME WALL . WITHOUT THE DESIRE FOR WINDOWS IN A GIVEN SITUATION MAINTAINING THE FULL HT BASEMENT WALL MAY PROVE MORE EFFECTIVE ALL AROUND.



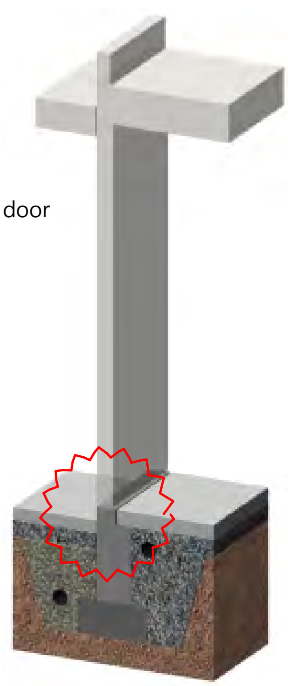
DAYLIGHT BASEMENT

6





WALK OUT



6

FULL HT FRAME WALL

***AT WALKOUT CONDITION**_FULL HT FRAME WALL THESE CONDITIONS WITH NO SOIL RETAINAGE OR SOIL LATERAL LOAD. THIS PROJECT DEFAULTS TO AN OPTIONAL 2X6 FRAMING BUT NOTE THIS 2X6 FRAMING MAY SOMETIMES BE CODE REQUIRED OF THE LOWER LEVEL FRAMING WHEN 2 LEVELS ABOVE EXIST.

***THE TRICKIER DETAIL**_IN THIS SITUATION IS AT BOTTOM OF WALL WHERE FOUNDATION WALL, SLAB, AND FRAME WALL MEET AND PROPER RIGID INSULATION IS REQUIRED.

CODE CHARTS FOR BASEMENT WALLS-BRACED AT TOP AND BOTTOM

*NOTE THE LIMITATION_THE CODE CHARTS ARE RESTRICTED TO WALLS THAT ARE RESTRAINED AT THE TOP AND BOTTOM. THEREFORE THE STEM WALL FOUNDATION, AND THE DAYLIGHT BASEMENT WALL ARE STRICTLY SPEAKING NOT INCORPORATED IN THESE CHARTS.
***CODE OPTIONS_**THE COMPLETE CODE CHARTS INCLUDE MANY TO MOST FOUNDATION WALL CONSTRUCTIONS -AND THICKNESSES OF WALL.
***CHARTS OR ENGINEERS DESIGN?_**CERTAINLY THESE CHARTS OFFER A GOOD STARTING PLACE FOR CONVERSATION ABOUT WALL CONSTRUCTION OPTIONS. AS ALWAYS LOCAL KNOWLEDGE AND PRACTICE AND ENGINEERING EXPERTISE MAY ENLIGHTEN THE CODE SUGGESTED SOLUTION.
***REINFORCING BAR_**WHEN REQUIRED #4 AND #5 BAR, (MAYBE #6) ARE USUALLY PREFERRED BY THE TRADES, AS THEY ARE EASIER TO BEND/CUT/INSTALL. IN GENERAL SMALLER BARS ARE INSTALLED AT CLOSER CENTERS AND THE SAME STRENGTH IS ACHIEVED. THE BELOW ILLUSTRATIONS INDICATE #6 BAR(3/4") AS INDICATED IN THE CODE CHART. THESE CAN BE 'CONVERTED' TO #4, OR #5 BAR. SEE TABLE R404.1.2(9) FOR BAR DIAMETER CONVERSIONS (THE ON CENTER DIMENSIONS WILL CHANGE).

WHAT MATTERS

1*TOTAL HT OF THE WALL MATTERS_THE WALL HT FOR A CMU WALL IS ITS TOTAL HT TO TOP OF FOOTING. THE HEIGHT OF A POURED CONCRETE WALL IS TO TOP OF SLAB IF THAT SLAB RESTS FULLY AGAINST THE WALL. IN EITHER CASE THAT WALL HT IS THE VERTICAL BEAM LENGTH.
2*HT OF THE UNBALANCED FILL MATTERS (DELTA)_ESTABLISHED ALREADY IS CONCEPT OF THE SOIL PRESSURE BEING A CONDITION OF THE VOLUME OF SOIL THAT TRANSLATES INTO THE LOAD. H/3 LOAD RESULTANT.
3*TYPE OF SOIL MATTERS_THE SOIL CLASSIFICATION HAS A 30#PSF, 45#PSF OR 60#PSF LOAD VALUE ASSOCIATED WITH IT BASED ON ITS INCLINATION TO RETAIN WATER. IF A WALL IS BACKFILLED WITH GRAVEL, WHICH WILL NOT RETAIN WATER, THE LOWEST LOAD CATAGORY CAN BE USED.

BELOW ILLUSTRATIONS

***A 10" WIDE WALL IS THE SAMPLE WALL_**

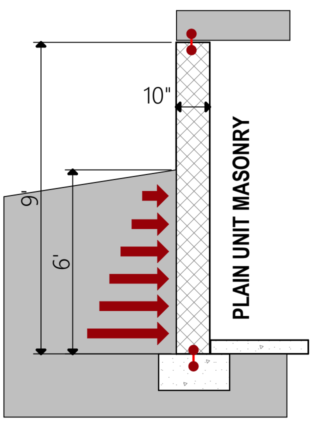


TABLE R404.1.1(1) PLAIN MASONRY FOUNDATION WALLS

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[c] (feet)	PLAIN MASONRY[a] MINIMUM NOMINAL WALL THICKNESS (inches) Soil classes[b]		
		GW, GP, SW and SP	GM, GC, SM, SM-SC and ML	SC, MH, ML-CL and inorganic CL
9	4	6 solid[d] or 8	6 solid[d] or 8	8
	5	8	10	12
	6	10	12	12 solid[d]
	7	12	12 solid[d]	Footnote e
	8	12 solid[d]	Footnote e	Footnote e
	9	Footnote e	Footnote e	Footnote e

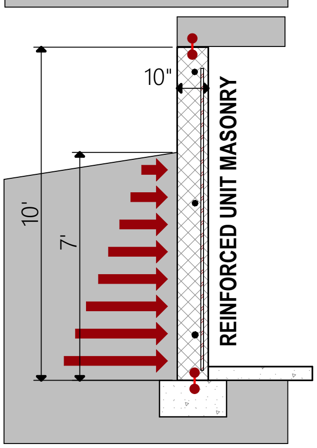


TABLE R404.1.1(3) 10-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE d > 6.75 INCHES[a, c]

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL[e]	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)[b, c] Soil classes and later soil load[d] (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
10 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#5 at 56	#6 at 56	#6 at 48
	8 feet	#5 at 56	#6 at 48	#6 at 40
	9 feet	#6 at 56	#6 at 40	#6 at 24
	10 feet	#6 at 48	#6 at 32	#6 at 24

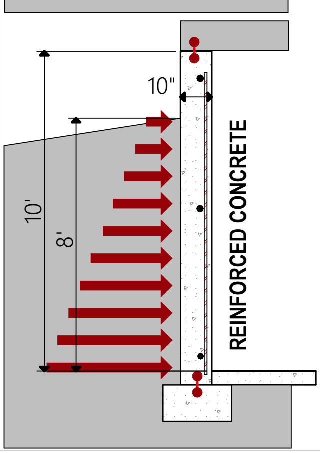
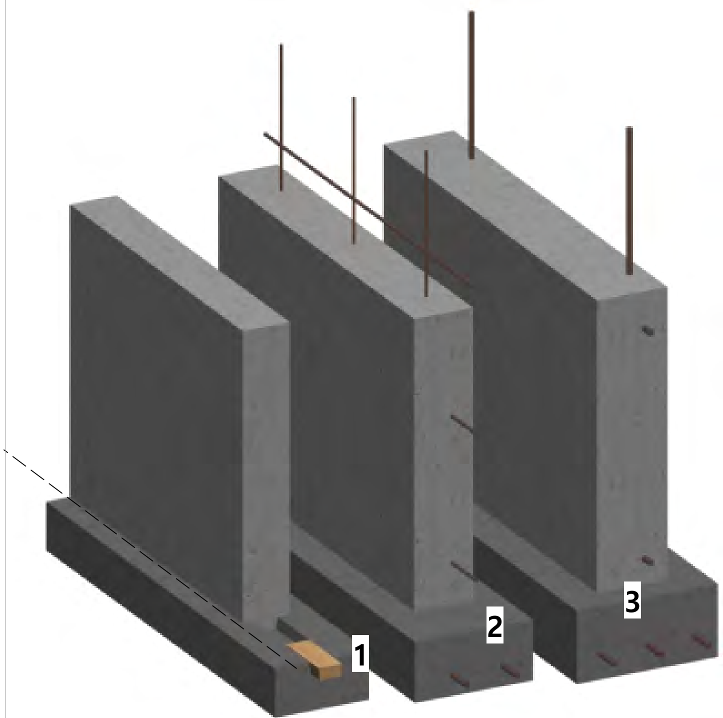


TABLE R404.1.2(4) MINIMUM VERTICAL REINFORCEMENT FOR 10-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 28
	8	NR	6 @ 28	6 @ 28
	9	6 @ 33	6 @ 28	6 @ 21
	10	6 @ 28	6 @ 23	6 @ 17

FOUNDATION WALL- CONSTRUCTION TYPES



POURED CONCRETE WALLS

***DESIGN TO THE PROJECT REQUIREMENT_** POURED CONCRETE WITH THE FLEXIBLE OPPORTUNITY TO REINFORCE CAN BE DESIGN-TARGETED TO MOST ANY SPECIFIC DESIGN CONDITION. THESE 3 OPTIONS ARE ILLUSTRATING A PECKING ORDER OF STRUCTURAL CAPABILITY. RESIDENTIAL FOUNDATION WALLS ARE SELDOM CHALLENGED BY GRAVITY LOADS. AN 8" WALL CAN CARRY MOST ANY LOAD TO A FOOTING-A FOOTING MAY NEED INCREASED SIZING. THE WEIGHT OF BOTH WALL AND FOOTING (DEAD LOAD) DOES NEED FULL CONSIDERATION IN TABULATING TOTAL GRAVITY LOADS. THESE WALLS ARE CHALLENGED BY SOIL PRESSURE LATERAL LOADS. -

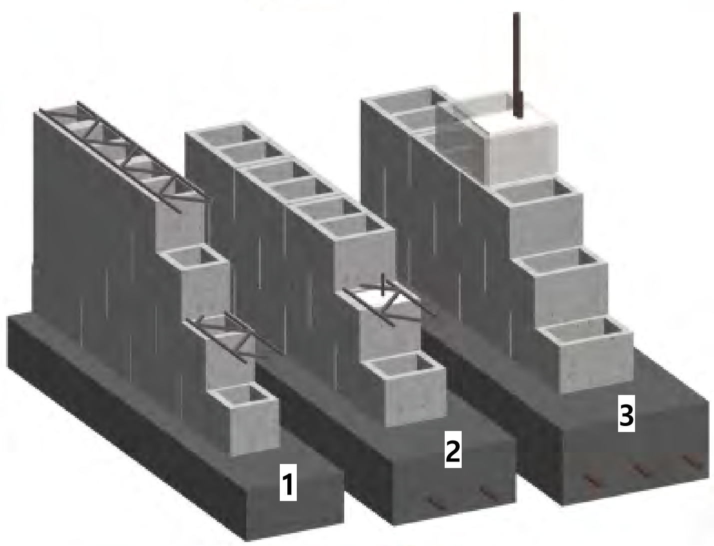
1*8" PLAIN CONCRETE_THIS ILLUSTRATION SHOWS A (FREQUENTLY ILLUSTRATED) 'KEYWAY' WHERE THE FOOTING AND WALL MEET. CREATED WITH A 2X4 'FORM' IN THE FOOTING, AND REMOVED FOR THE WALL POUR. VERTICAL REBAR MORE COMMON TO ADDRESS THE SLIDE ISSUE.

2*10" REINFORCED-ENHANCED DUTY_A MORE STANDARD WIDTH FOR REINFORCED WALLS AS MORE SPACE WITHIN WALLS PROVIDED TO GET REINFORCEMENT SET WHERE IT BELONGS. VERY CAPABLE WALL.

3*12" REINFORCED-HEAVY DUTY_BIGGER FOOTING/REINFORCEMENT AND LARGER REBAR AT INCREAESED CENTERS SHOW. OVERKILL FOR MOST RESIDENTIAL FOUNDATIONS.

***TABLE R404.1.2(8)_**IS A SUMMARY CHART FOR ALL WALL WIDTHS AND THEREFORE A SIMPLE RESOURCE FOR COMPARISONS.

***CONCRETE VOLUME_**FAIRLY COMMON FOR CONCRETE WORK TO BE COSTED BY CUBIC YARD IN PLACE. WASTING CONCRETE IS WASTING MONEY AND RESOURCES. OVERSIZING FOUNDATION WALLS HAS NO VALUE. **AND THE PRODUCTION OF CONCRETE IS NOT PLANET FRIENDLY.**



CONCRETE MASONRY UNITS(CMU'S)

***aka CONCRETE BLOCK_**AVAILABLE IN 4", 6", 8", 10", 12" WIDTHS. 8" HEIGHT AND 16" LENGTH IS STANDARD (EXCEPTIONS EXIST). ACTUAL DIMENSIONS ARE FRACTIONALLY LESS (3/8") ALLOWING SPACE FOR MORTAR WHILE MAINTAINING AN EVEN DIMENSIONAL SPACING VERTICALLY (8" MODULE), AND HORIZONTALLY (4",8",16" MODULE).

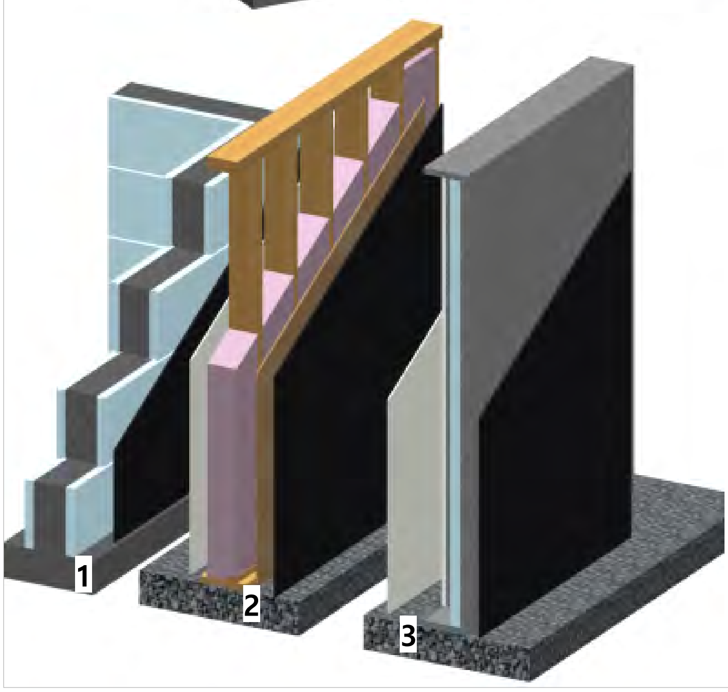
1*STANDARD DUTY_8" WALL

2*ENHANCED DUTY_10" WALL

3*HEAVY DUTY_12" WALL

***HORIZONTAL REINFORCEMENT_**A 9 GUAGE SHRINKAGE CONTROL REINFORCEMENT INSTALLED HORIZONTALLYEVERY OTHER COURSE IS STANDARD FARE. TRUSS AND LADDER GEOMTRIES EXIST. LADDER GEOMETRY CONSIDERED A BETTER CHOICE WHEN VERTICAL REINFORCEMENT IS REQUIRED AS IT DOES NOT INTERFERE WITH FREELY ACCESSING THE CORES.

***VERTICAL REINFORCEMENT_**REQUIRES (HOLLOW) BLOCK CORES TO BE ALIGNED AND FILLED WITH 'CORE FILL' WITH REBAR STUFFED IN THE FILLED CORES. PROCESS EXTENDS VERTICALLY AS THE WALL IS BUILT.



OTHER VIABLE OPTIONS

***INTERESTING CHOICES_**3 SYSTEMS NOTED BELOW ARE PERFECTLY ESTABLISHED, AND TOTALLY VIABLE AS FOUNDATION SYSTEM ALTERNATIVES. WHEN CONCIEVED, THEY ALL HAD AN EYE TOWARD COST AND INSULATION EFFECTIVENESS, AND IN MANY INSTANCES ACHIEVE THOSE GOALS. BUT, IN SO FAR AS THERE ARE NO MAGIC BULLETS IN CONSTRUCTION, EACH NEEDS CAREFUL INVESTIGATION, SUITABILITY ANALYSIS, AND LOCAL PRICING. WHEN ALL CHOICES THIS SHEET ARE CAREFULLY COMPARED AS COMPLETE AND FINISHED PRODUCTS, COST DIFFERENCES ARE NOT SO VAST, SO ULTIMATE VALUE BECOMES THE BETTER QUESTION.

1*ICF'S_INSULATED **C**ONCRETE **F**ORMS. MANUFACTURED FOAM CONSTRUCTED FORMS, STACKED ON SITE AND FILLED WITH CONCRETE. THINK LEGO'S.

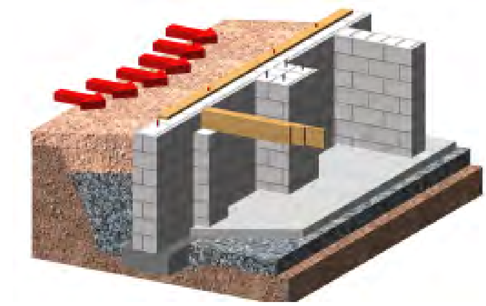
2*PWF_PERMANENT **W**OOD **F**OUNDATIONS_TREATED WOOD FRAME WALLS ON A TREATED 2X12 'FOOTER', ON A GRAVEL FOOTING/SUB SLAB BASE.

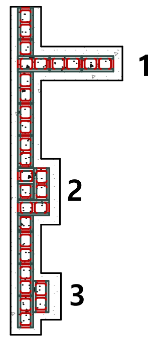
3*PRECAST PANEL WALLS(SUPERIOR WALLS)_CONCRETE PREFAB PANELS WITH SELECTABLE INSULATION VALUE, PRE-ENGINEERED AND MANUFACTURED, AND CRANE INSTALLED ON A GRAVEL FOOTING/SUB SLAB BASE.

***INVESTIGATION_**YOU TUBES AGAIN BECOME A SMART INVESTIGATION TOOL AS THEY BRING THE CONSTRUCTION PROCESS ALIVE WHICH IS AN ALL IMPORTANT INGREDIENT IN VALUING A SYSTEM. MANUFACTURER OR VENDOE PRODUCED YOU-TUBES WILL OF COURSE ONLY SHOW WHAT THEY WANT YOU TO SEE.

PARTIAL HEIGHT MASONRY WALLS-OUTSIDE PRESSURE

***HYBRID FOUNDATION WALL**_THESE SOLUTIONS TO PRESSURE ON THE FOUNDATION PORTION OF THE HYBRID FOUNDATION WALL WILL INSTRUCT A LITTLE, EVEN IF NOT APPLICABLE. THE HORIZONTAL BOND BEAM IS A RECOMMENDATION AS IT DOES NOT INTERRUPT ANYTHING FROM A CONSTRUCTION STANDPOINT EXCEPTING ORDERING THE BOND BEAM BLOCK.





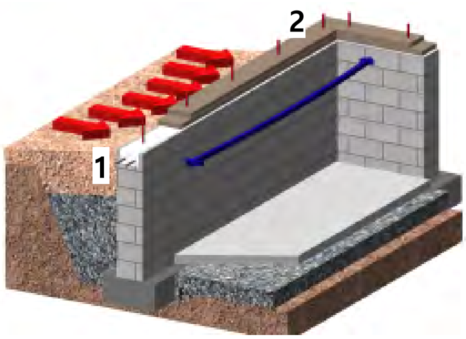
HALF PIERS/PILASTERS/SHEAR WALLS

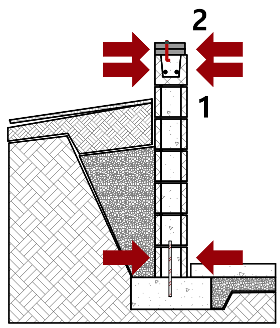
***OVERVIEW**_THESE ARE 3 DIFFERENT WAYS TO VERTICALLY REINFORCE THE RUNNING CMU WALL. BOTH THE TECHNIQUE AND THE 'RUN' BETWEEN THE VERTICALS DETERMINE THE STRUCTURAL VALUE.. LONGER RUNS ARE MORE SUSCEPTIBLE TO A COMPOUND BOWING AT THE TOP OF WALL. BETTER SELECTION, AS ALWAYS, IS BASED ON THE WALL HT AND THEREFORE THE SOIL PRESSURE.

1*SHEAR WALL_IS BASICALLY A RETURN WALL. WHEN ITS LENGTH EQUALS ITS HEIGHT IT BECOMES PRETTY SUBSTANTIAL.

2*PILASTER_THIS BULKIER REINFORCED PILASTER CAN FUNCTION LIKE A VERTICAL CANTILEVERED BEAM IF REINFORCED INTO SLAB. AS A BULK PILASTER ONLY IT IS STIFFENING THE RUNNING WALL. STRONGER WHEN THESE ARE 'TOOTHED' INTO THE RUNNING WALL.

3*STANDARD HALF PIER_IS A SIMPLE WALL REINFORCEMENT USUALLY 8" DEEP AND 16" WIDE





SIMPLE CMU WALL ENHANCEMENTS

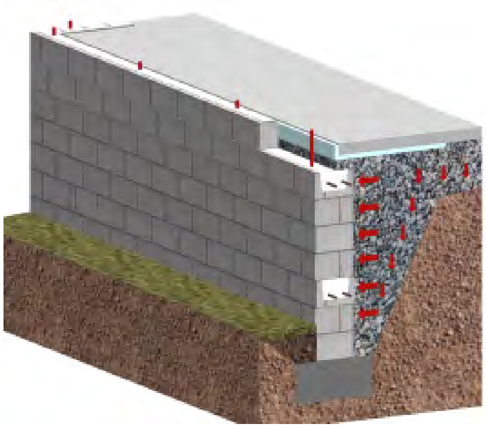
***OVERVIEW**_2 VAAITIONS OF A HORIZONTAL BEAM RESISTING THAT OUTSIDE SOIL PRESSURE.

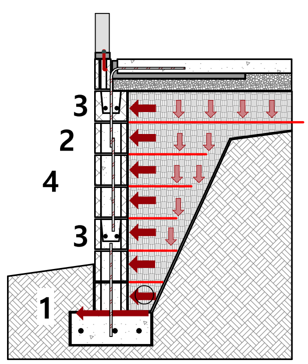
1*BOND BEAM_BEST CONSTRUCTED WITH THE 'U'SHAPED BOND BEAM BLOCK WITH RUNNING REINFORCEMENT SET WITH CORE FILL. ADDITIONAL VERTICAL REINFOCEMENT A QUESTION OF DIFFERENTIAL FILL.

2*HORIZONTAL PLATES_A COUPLE TREATED FULL DEPTH PLATES ANCHORED INTO A TOP BLOCK COURSE IS A LESS SUBSTANTIAL STRUCTURAL SOLUTION BUT IN SOME INSTANCED ADEQUATE. MAILING THE PLATES IN A TIGHTER PATTERN WILL HAVE THE 2 MEMBERS WORKING TOGETHER A LITTLE MORE EFFICIENTLY.

PARTIAL HEIGHT MASONRY WALLS-INSIDE PRESSURE

***2 CONDITIONS**_HAVE BEEN OUTLINED THIS CHAPTER. THESE ILLUSTRATIONS ARE SHOWING A LITTLE MORE CONSTUCTION DETAILING.





REINFORCED STEM WALL

***OVERVIEW**_THIS CONDITION EXPLAINED (c2.12). WITH REINFORCING AS SHOWN THIS WALL COULD BE TALLER.

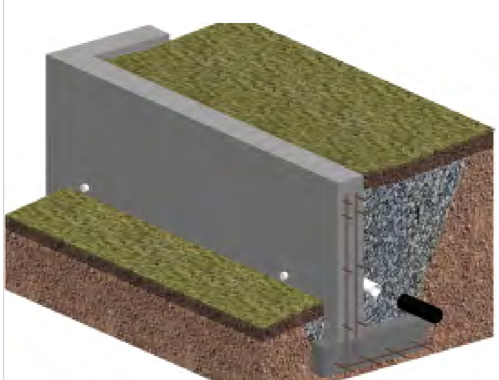
1*SLIDE/FOOTING TIE_REBAR FROM FOOTING UP INTO THE BLOCK WALL

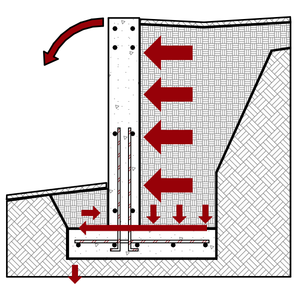
2*VERTICAL REINFOREMENT_ EXTENDS VERTICALLY UP THE WALL TO THE TOP. RUNNING THESE THRU THE BOND BEAM BLOCK REQUIRES A LITTLE CARE/PATIENCE.

3*BOND BEAM(S)_WHEN COMBINED WITH VERTICAL REINFORCEMENT A TRUE REINFORCED MAT IS REALIZED.

4*TIE TO SLAB_WITH TIE TO SLAB THIS WALL IS A VERTICAL BEAM. WITHOUT TIES THIS IS A CANTILEVERED RETAINING WALL. SEE BELOW.

5*DRAINAGE_NOT SHOWN.





FLEXIBILITY OF THE REINFORCED CONCRETE WALL

***OVERVIEW**_THE RETAINING WALL HAS COMMON STRUCTURAL CHALLENGES TO THE STEM WALL ABOVE WITH THE SIGNIFICANT ADDITIONAL CHALLENGE OF NOT BEING TIED TO A SLAB AT THE TOP. ILLUSTRATED IS BUT ONE COMMON WALL PROFILE. MANY OTHER APPROACHES TO RETAINING WALL DESIGN EXIST.

1*SLIDE/FOOTING TIE_DITTO ABOVE.

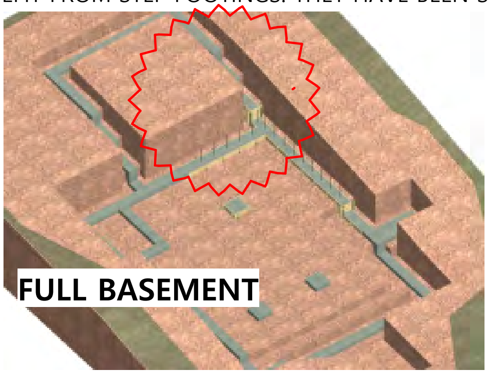
2*OVERTURNING_ALL RETAINING WALLS WANT TO TIP OVER. WIDER AND FREQUENTLY DIMENSIONALLY OFFSET FOOTINGS BOTH AID IN THE MECHANICAL ADVANTAGE WITH THE SOIL AND THE OPPORTUNITY FOR BETTER REINFORCEMNT DEVELOPMENT TIEING WALL TO FOOTING.

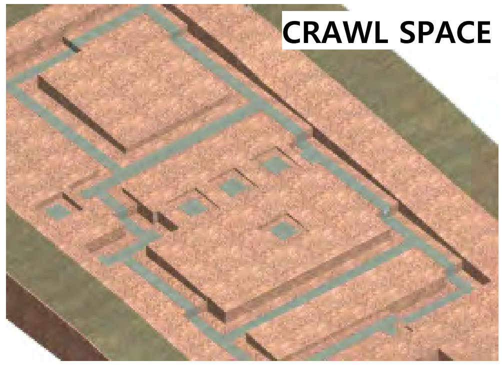
3*WALL_IF THERE IS LITTLE BACKFILL ON THE OUTSIDE WALL SLIDE IS A POSSIBILITY. IF THERE IS A LOT THEN NOT.

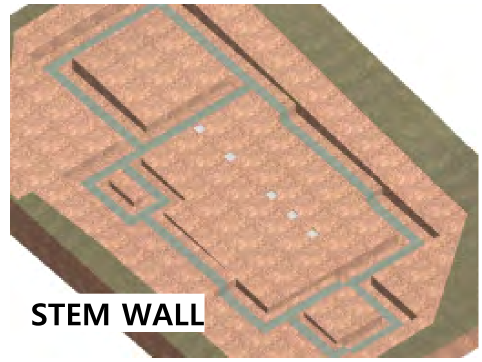
4*CONTINUAL PRESSURE RELIEF_INSTALLING 'WEEPS' IN A RETAINING WALL ALONG ITS LENGTH CAN BE REALLY SMART RELIEVING WATER PRESSURE AS IT BUILDS. RETAINING WALLS ARE TYPICALLY OPEN TO ACTIVE PRECIPITATION.

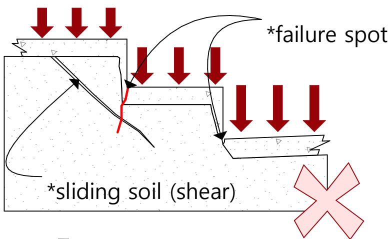
STEPPED FOOTINGS

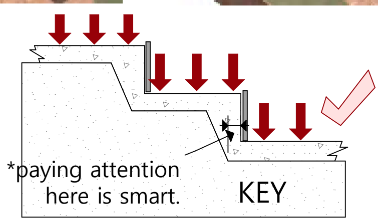
***OVERVIEW**_STEP FOOTINGS 'FOLLOW' GRADE, AND KEEP THE BOTTOM OF FOOTING AT FROST DEPTH. ALL FOUNDATION TYPES MAY REQUIRE OR BENEFIT FROM STEP FOOTINGS. THEY HAVE BEEN SUGGESTED, DRAWN, OUTLINED, IN ALL ILLUSTRATIONS IN PREVIOUS SECTIONS.









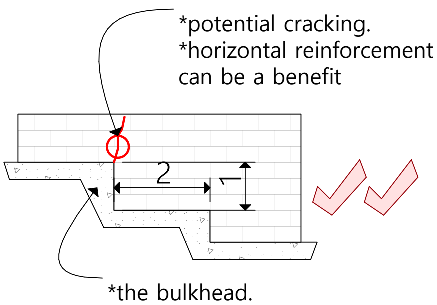


2 FAILURE CONCERNS

***SOIL SHEAR**_STEPPED EXCAVATION OFFER A PLACE FOR SOIL TO SHEAR OR SLIDE EVEN IF BY HUMAN TRAFFIC OR ACCIDENT.

***DIFFERENTIAL SETTLEMENT**_THIS CHANGE IN ELEVATION ALSO OFFERS A PLACE FOR DIFFERING SETTLEMENT, ALTHOUGH SLOPPY CONSTRUCTION IS MORE LIKELY A CULPRIT.

***FOOTING OVERLAP & THE BULKHEAD**_A SIMPLY FORMED BULKHEAD AT THESE VERTICAL STEPS IS CRITICAL TO MANAGING THE FOOTING CONTINUITY. A LITTLE MORE CONCRETE AT THE BULKHEAD CANNOT HURT.

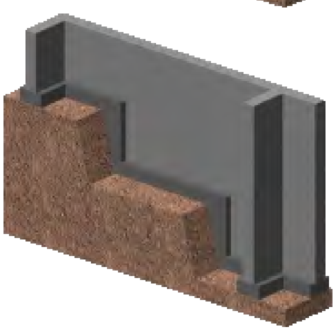


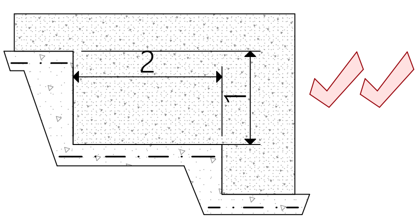
STEP FOOTINGS FOR CMU FOUNDATIONS

***2 IN 1**_THE 2 IN 1 RULE IS THE MAX RISE TO RUN RATIO RECOMMENDED. 3 IN 1 WOULD BE MORE GENTLE AND FORGIVING

***VERTICAL COURSING**_VERTICAL COURSING IS 8" WITH CMU UNITS. THE STEPS SHOULD THEN HOLD AN 8" VERTICAL INCREMENT. 16" AND 24" INCREMENTS ARE GOOD. TALLER VERTICAL INCREMENT THAN 24" PUTS MORE PRESSURE ON PROPER FORMING FOR THE BULKHEADS

***HORIZONTAL COURSING**_IN THEORY HOLDING TO 16" INCREMENTS IS NICE, BUT THE EXCAVATOR HAS HIS OWN CHALLENGES___HORIZONTAL COURSING IS A LOWER PRIORITY.

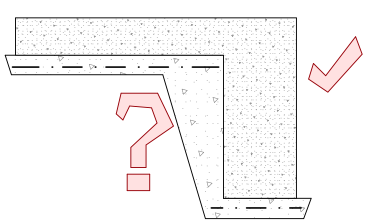




STEP FOOTINGS FOR CONCRETE FOUNDATIONS

***2 IN 1 RULE**_AS A GUIDELINE IS OPEN TO SOME MANIPULATION WITH CONCRETE CONSTRUCTION INCLUDING THE LARGER DIMENSIONAL STEP SHOWN THIS ILLUSTRATION. THE CONCRETE CONTRACTOR KNOWS HOW TO DO FORMS SO THE BULKHEADS HAVE A BETTER CHANCE OF COMING OUT CLEAN.

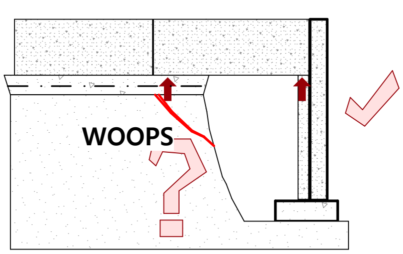
***COURSING**_BASED ON CONCRETE FORMS. EXCAVATOR AND CONCRETE CONTRACTOR SHOULD CONCSULT.



THE GARAGE TO BASEMENT CONDITION

***BIG TRANSITION**_THE VERTICAL TRANSITION FROM GARAGE FLOOR ELEVATION TO BASEMENT FLOOR ELEVATION CAN BE 6 OR MORE FEET.

***1 STEP**_AS SHOWN A SINGLE STEP IS POSSIBLE BUT WOULD REQUIRE A SERIOUS BULKHEAD. A FIRM NON COLLAPSING SOIL WOULD BE NEEDED. GIVEN THAT IS BECOMES A QUESTION OF THE ECONOMY OF MEANS.



USING THE FOUNDATION WALL AS A BEAM

***SPANNING THE GAP**_THIS APPROACH IS ONE SPECIFICALLY DESIGNED FOR USING A PRECAST FOUNDATION SYSTEM (SUPERIOR WALLS). THE PRECAST PANELS AVAILABLE ARE PRE-DESIGNED, STRUCTURAL AND HAVE LISTED SPAN CAPACITIES. THIS APPROACH WOUD NOT BE VIABLE USING BLOCK OR CONCRETE SYSTEMS.

***RISK**_SOIL SHEAR AND COLLAPSE IS A DEFINITE CONCERN THIS DETAIL. THE CONSTUCTION OF THE SPANNING MEMBER DOES NOTHING TO STABILIZE THE SOIL. SOIL TYPE/CONDITION IS CRITICAL.