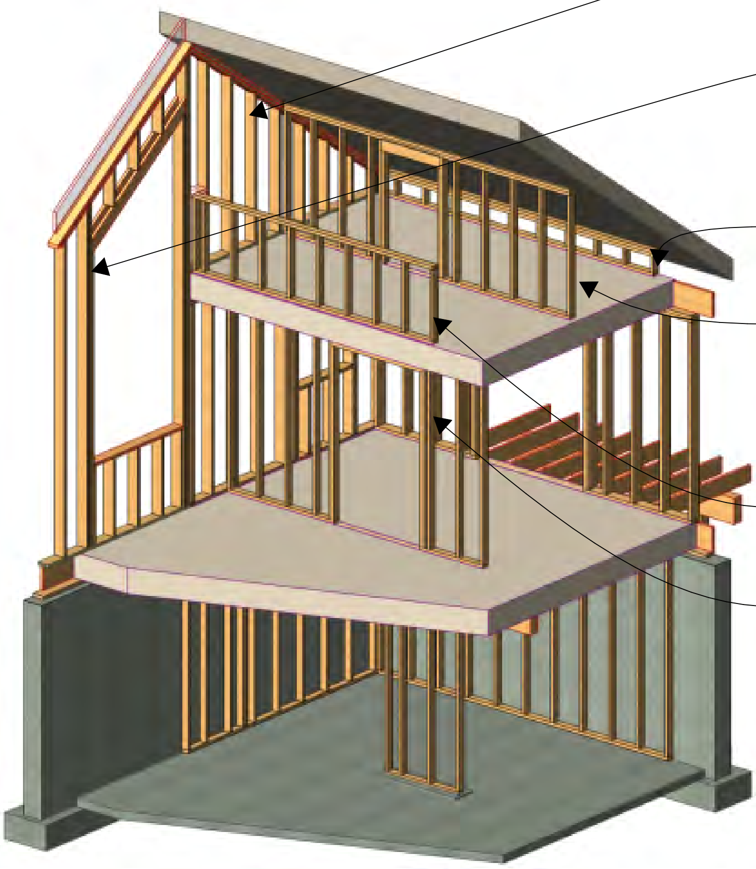
FRAME WALL FLEXIBILITY



*SLOPED END WALL_gable 'non bearing wall. No special requirements.

*TALL WALL_gable 'non bearing' end wall. 2x6 framing member at minimun these tall walls.(c6.6-C6.8). Opening for a large trap window assembly shows. A double rafter above this wall would sometimes serve as the header for the window. The cripples as shown would still need to be there.

*RAFTER BEARING KNEE WALL_this is the simple wall that allows one to raise a roof-incrementaly-to whatever ht works. Ventilation+ insulation is another issue that this baby kneewall can help manage.

*ATTIC KNEE WALL_this wall may or may not be a bearing wall is conditional on where we want the roof loading to track. There is flexibility where this wall get located. If set at a 5' height the finished space in the walkway is considered 'habitablel' finished footage, and the space under roof does not require access, but can be installed if desired.

*LOFT SAFETY WALL_a 36" high wall becomes the guard rail. Generally these half walls are more closed and less expensive than a railing.

*INTERIOR BEARING WALL_carrying floor joists above and transfering loads to basement level. This header is a load bearing header.

*REAR EXTERIOR WALL_door access to the deck requires a structural header.

*INTERIOR BEARING WALL_carrying floor joists above and transfering loads to basement level. This header is a load bearing header.

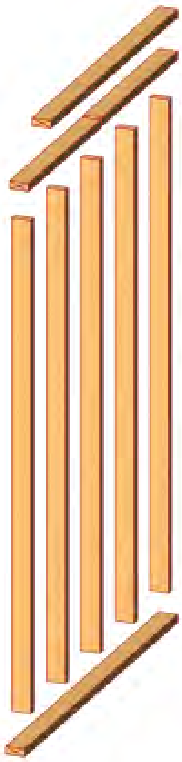
*LINER WALLS_these perimeter interior basement walls are non bearing. But likely required to carry insulation and permit the attachment of interior finihes such as sheetrock.

*SHORT BEARING WALL_the short wall under the bearing beam can be any length that suits the layout and structural condition. (c5.15)

*DROP BEARING BEAM_(c5) wood beam showing.

*DROP BEARING BEAM SUPPORT_(c5.14) a beam pocket can be set in the foundation wall during its construction. A pocket allows bearing to be delivered thru the foundation wall to the footing. Another option is placing a 4x4 treated wood post against the foundation wall during floor framing and preferably have it set directly on top of the footing. An additional option is creating a beam pocket in the interior liner wall with a couple of studs below the beam. These 3 options all viable structurally.

FRAME WALL COMPONENTS



TOP PLATE(S)

*TYPICALLY AN OFFSET STACKED 2 MEMBER ENTITY HOLDING THE STUDS IN ALIGNMENT, DISTRUBTING LOADING FROM ABOVE, AND PROVIDING THE NAILING BASE FOR WALL COVERING. SINGLE MEMBER IS AN OPTION.

STUDS

*THE VERTICAL SUPPORT MEMBERS

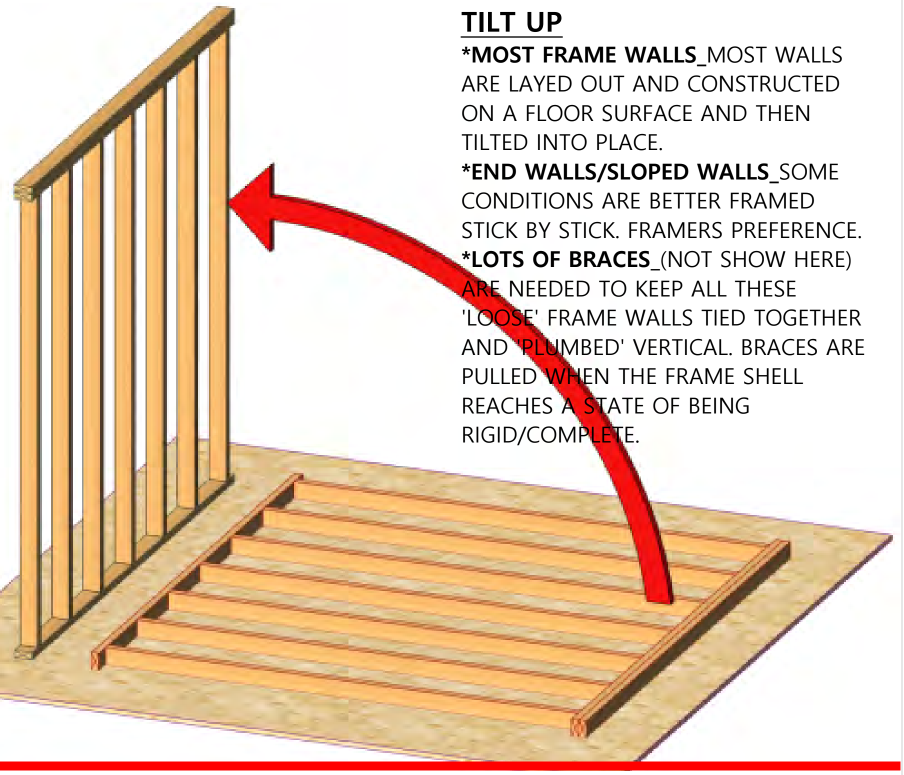
BOTTOM PLATE

*A SINGLE MEMBER AT THE FLOOR PLANE THAT DISTRIBUTES THE WALL LOAD AND PROVIDES A NAILING BASE FOR WALL COVERING.

CHOICES

***BASE MEMBER SIZE**_MOST OFTEN 2X4 OR 2X6 AND REQUIRES CONSISTENT USE FOR PLATES AND STUDS.

***CENTERS**_REFER TO THE CENTERS OF THE VERTICAL STUDS. 16", AND 24" ARE THE MOST COMMON STANDARD SPACING.



TILT UP

***MOST FRAME WALLS**_MOST WALLS ARE LAYED OUT AND CONSTRUCTED ON A FLOOR SURFACE AND THEN TILTED INTO PLACE.

***END WALLS/SLOPED WALLS**_SOME CONDITIONS ARE BETTER FRAMED STICK BY STICK. FRAMERS PREFERENCE.

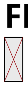
***LOTS OF BRACES**_(NOT SHOW HERE) ARE NEEDED TO KEEP ALL THESE 'LOOSE' FRAME WALLS TIED TOGETHER AND 'PLUMBED' VERTICAL. BRACES ARE PULLED WHEN THE FRAME SHELL REACHES A STATE OF BEING RIGID/COMPLETE.

STUDS & LUMBER GRADES

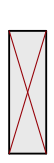
***CODE**_REQUIRES BEARING STUDS TO BE #3 GRADE, STANDARD GRADE, OR STUD GRADE. THE STRESS RATINGS OF THESE GRADES ARE CLOSE TO SIMILAR. NON BEARING STUDS MAY BE UTILITY GRADE. UTILITY GRADE PERMITS ENOUGH KNOTS AND IMPERFECTIONS THAT ITS STRUCTURAL DEPENDENCY IS LIMITED. FOR SHORT SECONDARY FRAMING REQUIREMENTS IT IS OKAY STRUCTURALLY.

***LUMBER YARD CHOICES**_THE MORE IMPORTANT CRITERION IN SELECTING WHAT STUDS TO USE IS STRAIGHTNESS. LOUSY/CROOKED STUDS CAUSE UNENDING PROBLEMS. YARDS USUALLY OFFER A 'PRIME' GRADE (THEORETICALY STRAIGHTER AND STRONGER), AND A UTILITY GRADE. A GOOD LUMBER YARD WILL BE CAREFUL IN ITS BUYING/PROVIDING A DECENT STUD. A COMMODITY PROVIDER MAY NOT BE AS CAREFUL. A 'PRIME' STUD WILL MEET THE #3,STANDARD, STUD GRADE CODE REQUIREMENT.

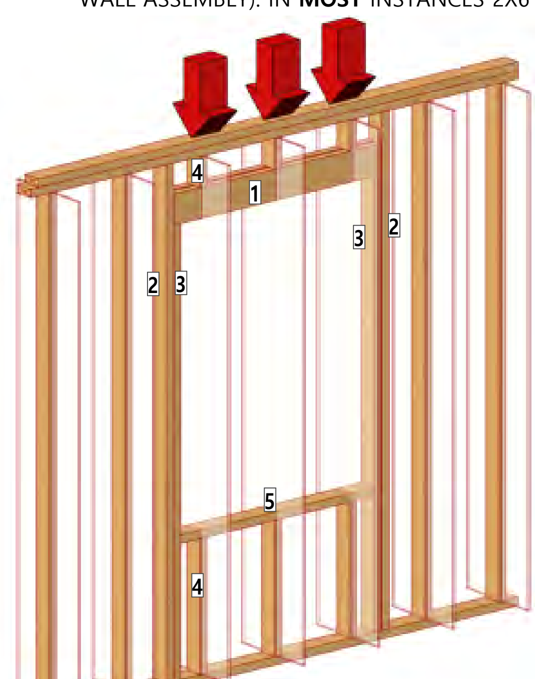
FRAME WALL LUMBER OPTIONS



2X4_IS THE UBIQUTOUS FRAME WALL MEMBER. PLENTIFUL, CHEAP, AND FLEXIBLE.



2X6_IS AN INCREASINGLY COMMON CHOICE FOR EXTERIOR WALLS AND IS THE DEFAULT USED THESE PROJECTS. 2X4 OR 2X6 IS AN IMPORTANT DECISION FOR ALL PROJECTS. DECISION CRITERIA IS COST, STRUCTURE, AND HYGRO-THERMAL PERFORMANCE (OF THE ENTIRE WALL ASSEMBLY). IN **MOST** INSTANCES 2X6 WALLS ARE **NOT** NEEDED STRUCTURALLY.



WINDOW OPENING

PARTS

1***HEADER**_SUPPORTS LOADING ABOVE.

2***KING STUD**_IS FULL HT AND LIKELY NOT CONSISTENT WITH THE ON CENTER FRAMING. HOLDS THE WINDOW OR DOOR JAMB STABLE.

3***JACK STUD**_IS THE SUPORT STUD FOR THE HEADER-SITS UNDER THE HEADER.

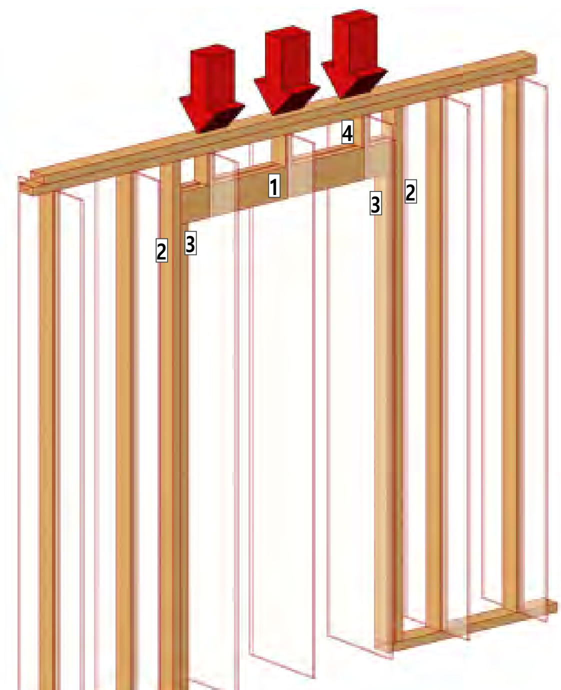
4***CRIPPLES**_SHORT STUDS BETWEEN HEADER AND WALL PLATE.

5***SILL**_AKA SUBSILL OR SADDLE

NOTES

1***FRAMING CENTERS**_MUST BE MAINTAINED ABOVE HDR AND BELOWS SILL TO ACCOMODATE SHEETGOOD'S FACTORY EDGES AND THEIR NAILING.

2***LOAD DISTRIBUTION**_THE HEADER FUNCTIONS AS A BEAM AND DISTRIBUTES 50% OF THE LOAD DOWN EACH SIDE OF OPENING CARRIED DIRECTLY BY THE JACK STUD(S)

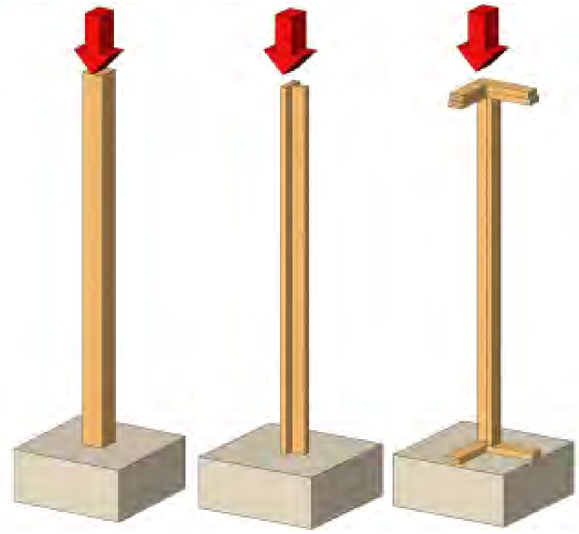


DOOR OPENING

THE STUD UNDER LOAD (c5.16)

***A STUD IS A POST_** ON ITS OWN 1 STUD HAS A TENDENCY TO BOW/BEND/WOBBLE UNDER LOAD. THE STUD CAN HANDLE A SIGNIFICANT LOAD **IF** IT CAN BE KEPT PLUMB AND STRAIGHT.

***KEEP THE STUDS PLUMB_**THE RECTANGULAR PROPORTION OF A STUD NECESSARILY GIVE IT A STRONGER AND WEAKER DIRECTION. IT WILL ALWAYS BOW IN THE WEAKER DIRECTION. A SQUARE PROPORTION (4X4,6X6,8X8) IS A MORE STABLE PROPORTION BECAUSE IT DOES NOT HAVE A "WEAK' DIRECTION. PLACING STUDS AT 90° ALSO INCREASES THAT 2 DIRECTIONAL STABILITY. AND PLACING THOSE STUDS IN A CORNER CONSTRUCTION IS BEST AS THEY ARE LOCKED IN A STABLE POSTURE.



GRAVITY LOAD (AXIAL)

***UNIFORM LOADING_**WITH UNIFORM LOADING FROM ABOVE THE STUD WALL PERFORMS WELL. (c6.6, c6.7) DISCUSSES LIMITS. STUD WALLS **CAN** REACH THEIR GRAVITY LOAD LIMITS, AND WILL WANT TO BOW/BEND.

***KEEP THE STUDS PLUMB_**BLOCKING, CROSS BRACING, SHEETGOODS (AT RIGHT) ARE ALL WAYS TO KEEP THOSE STUDS PLUMB. IN THEIR PLUMB STATE THEN EACH STUD AND THE STUD WALL CAN MANAGE CONSIDERABLE LOADING.

LATERAL PRESSURE (PERPENDICULAR)

***LATERAL 'LOADING'_**FOR FRAME WALLS IS WIND BASED. THE ILLUSTRATION SHOWS THE PUSH (WINDWARD SIDE). THE NATURE OF WIND IS THAT IT CAN BE EQUALLY STRONG ON THE PULL (LEEWARD SIDE). EITHER DIRECTION EFFECTS THE STUDS THE SAME WAY. THEY ARE BEING ASKED TO FUNCTION AS VERTICAL BEAMS.

***KEEP THE STUDS STIFF_**DEEPER STUDS ARE 'STRONGER', MORE STUDS REDUCE THE LOAD PER STUD, 'STRUCTURAL' COVERING OF THE STUD WALL TRANSFORMS A WALL INTO A MUCH MORE EFFECTIVE STRUCTURAL ENTITY.

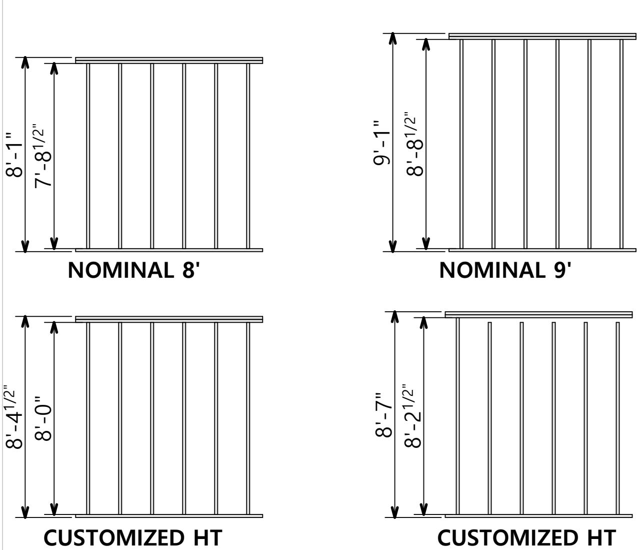
LATERAL PRESSURE (PARALLEL)

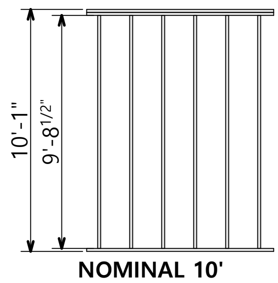
***LATERAL LOADING 2_**THAT SAME WIND HITTING THE WALL ABOVE WILL WANT TO PUSH ALL WALLS FRAMED 90° TO THAT FORCE.

***THIS DIRECTION_**IS WHERE THE STUD WALL, WITHOUT HELP, IS MOST VULNERABLE. THIS IS THE 'HOUSE OF CARDS' FAILURE POSITION. FULLY NAILED SHEETROCK, STRUCTURAL BRACING,AND STRUCTURAL SHEATHING WILL ALL KEEP THOSE WALL STANDING.

OPTIONS - FRAME WALL HEIGHTS

***EXACT DIMENSIONAL NOTE ON FRACTIONS**_REMEMBERING THIS IS NOT A FRAMERS GUIDE BUT A DECISION GUIDE, FRACTIONS OF AN INCH THAT MAY BE CRITICAL TO GOOD TIGHT FRAMING ARE BEING AVOIDED/OVERLOOKED. DIMENSIONS ARE ROUNDED TO THE NEAREST 1/2"





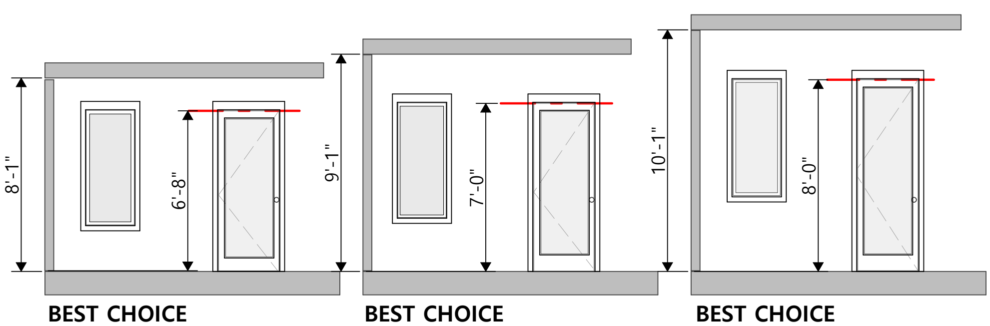
CEILING HT OBSERVATION
*CEILING HTS BETWEEN 8' AND 9' ARE WORTH SOME CONSIDERATION. SOINDS PICKY, BUT 8' CAN BE LOW, AND 9' TOO HIGH.
*CHECK IF ANY SHEETGOOD DIMENSIONS-INSIDE AND OUT-WILL CAUSE ANY HEADACHES.
*8'-7" WILL WORK WITH 4'+4'-6" SHEETROCK INSTALLED HORIZONTALLY

WALL HTS=CEILING HTS

***8',9',10'**_ARE THE 3 INDUSTRY STANDARD CEILING HTS.
***PRECUT STUDS**_ARE ACCURATELY PRECUT TO CONSISTENT EXACT LENGTHS. 7-8 5/8" PRECUTS WITH 4 1/2" OF PLATE GENERATES A TOTAL ACTUAL HT OF 8'-1 1/8"-THE NOMINAL 8' WALL HT/CEILING HT. 8-8 5/8" PRECUTS WITH 4 1/2" OF PLATE GENERATES A TOTAL ACTUAL HT OF 9'-1 1/8"-THE NOMINAL 9' WALL HT/CEILING HT. 9-8 5/8" PRECUTS WITH 4 1/2" OF PLATE GENERATES A TOTAL ACTUAL HT OF 10'-1 1/8"-THE NOMINAL 10' WALL HT/CEILING HT.
***CUSTOM CEILING HTS**_ ANY NON PRE CUT STUD NEEDS TRIMMING. EVEN STOCK 8' STUDS, FOR EXAMPLE, CAN VARY 1/8" OR SO, WHICH IS UNACCEPTABLE. POINT BEING ANY NON PRECUT NEEDS TRIMMING WHICH OPENS UP THE IDEA OF CUSTOM WALL HEIGHTS.

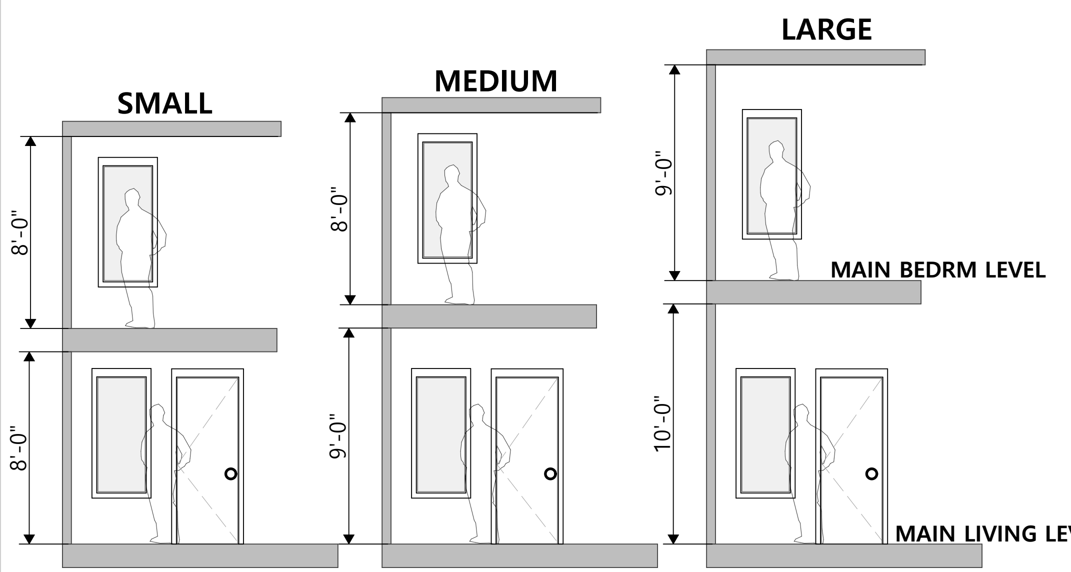
HEADER RESOLUTION

***DOOR HT** _DOOR ROUGH OPENING HEADER AND TOP PLATES NEED TO FIT WITHIN THE PROJECTED CEILING HT. THERE ARE ONLY A FEW SITUATIONS WHEN THIS CAN BE A PROBLEM. ONE IS WITH 8' DOORS/WINDOW HEAD HT FOR BIG ASSEMBLIES IN A 9' CEILING HT ON EXTERIOR BEARING WALLS. THE CHALLENGE IS FITTING A SATISFACTORY STRUCTURAL HEADER.
***GENERAL**_(c6.9) SMART TO CONSIDER HEADER CONSTRUCTION IN GENERAL FOR A PROJECT AND APPLY THAT TECHNIQUE THROUGHOUT.



PROPORTIONAL HEAD HEIGHTS

***STAYING WITH STANDARDS**_THESE THREE HEAD HTS PROBABLY WORK BEST WITH THESE 3 CEILING HTS FROM THE GENERAL STANDPOINT OF PROPORTION. THE PRIMARY LIMITATION IN THESE LIMITED OPTIONS IS THE STANDARD HEIGHT OF DOORS. 6'-8", 7', 8' ARE STANDARD DOOR HTS.
***EXCEPTION**_THIS PROJECT DESIGNS FREQUENTLY SHOW 8' HEAD HEIGHTS (ON EXTEROR WALLS) WITH 9' CEILINGS DRIVEN BY A DESIRE FOR MORE EXTERIOR GLASS (AND LIGHT).

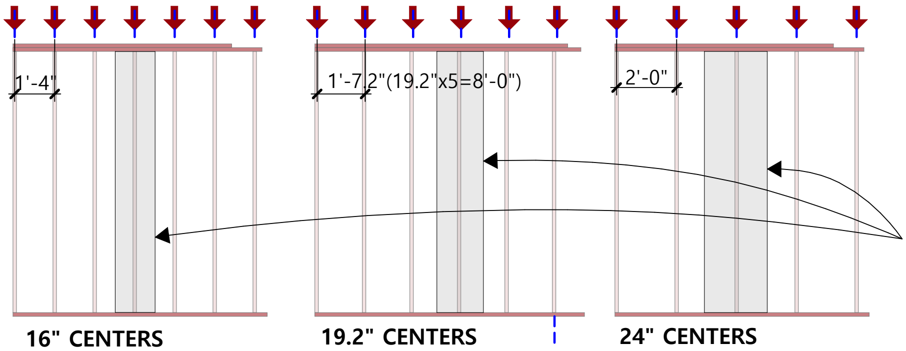


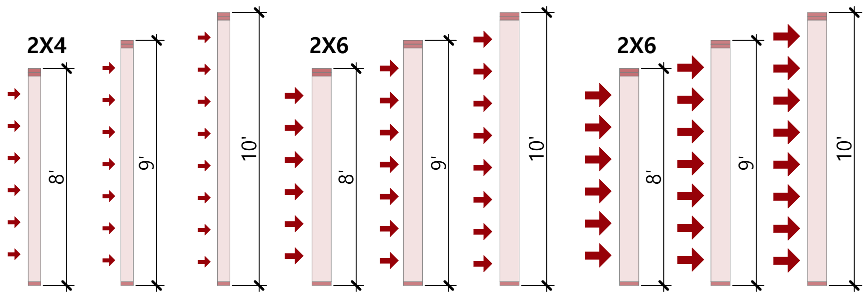
BUILDING HEIGHTS

***STANDARDS**_LIVING SPACES ON A MAIN LEVEL MAY MERIT A HIGHER CEILING. SLEEPING FUNCTIONS ON AN UPPER LEVEL SHOWING LOWER CEILINGS. THESE ARE STANDARD COMBINATIONS.
***SCALE**_CEILING HTS HAVE A RELATION TO OVERALL SIZE AND SCALE OF A DESIGN. SMALLER HOMES WOULD FEEL QUITE AWKWARD WITH 10' CEILINGS. AND BIG SPACES AWKWARD WITH 8' CEILINGS. THERE IS A BALANCE AND PROPORTION REQUIRED.
***MORE IS MORE**_REMAIN AWARE THAT GREATER CEILING HTS REQUIRE MORE MATERIAL VOLUME AND CREAT A GREATER VOLUME OF SPACE THAT NEEDS TO BE CONDITIONED.

OPTIONS - FRAME WALL MEMBERS AND SPACING

***ROOF,WALL,FLOOR CENTERS_**THERE ARE CRITERION FOR SELECTING CENTERS FOR ALL REPETITIVE FRAMING. THE CRITERION CAN SHIFT A BIT FROM FUNCTION TO FUNCTION. BELOW OUTLINES WALL CRITERION.
***NOTE ON 19.2 CENTERS_** 19.2 CENTERS ARE NOT A MAINSTREAM SELECTION FOR WALLS MOSTLY BECAUSE IT MISSES THAT 48" CENTER. TOO BAD BECAUSE 19.2 IS A GREAT COMPROMISE IN TERMS OF STRUCTURE & EFFICIENCY-FOR WALLS, ROOFS, AND FLOORS



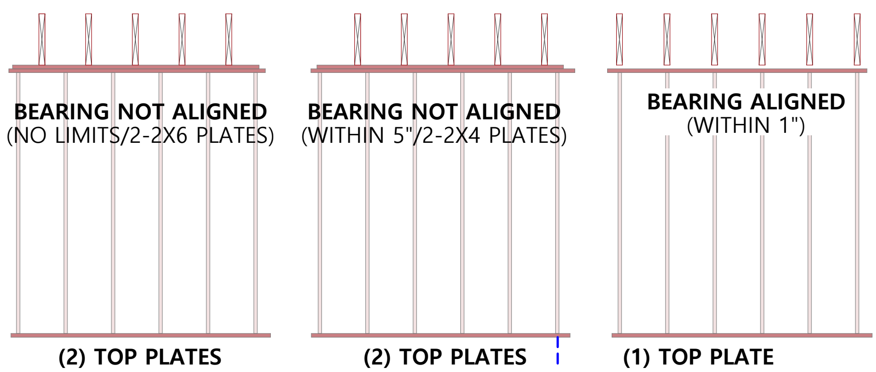


GRAVITY LOADING

***DISTRIBUTION_**THE SAME TOTAL LOAD ON A WALL GETS DISTRIBUTED PRETTY EQUALLY TO EACH STUD. MORE STUDS = LESS LOAD PER STUD. FEWER STUDS = MORE LOAD PER STUD.

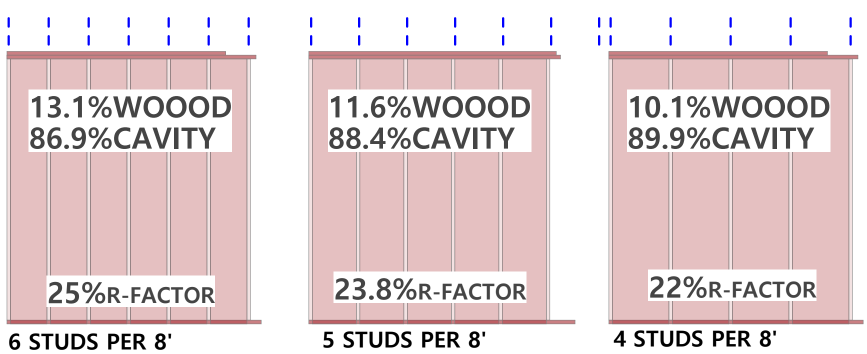
WIND LOADING

***TRIBUTARY BASED ON CENTERS_**16" CENTERS COLLECT LESS TRIBUTARY AREA ACTING ON A SINGLE STUD THAN 19.2" OR 24" CENTERS. THINKING OF A STUD AS A SINGLE (VERTICAL) BEAM THE REQUIRED LOAD RESISTANCE PER STUD IS LESS.
***STUDS AS VERTICAL BEAMS_**THE SPAN IS THE STUD HT. THE STUD DEPTH IS THE BEAM DEPTH. DEPTH IMPROVES THE LOAD RESISTANCE.
***WIND LOADING_**WIND SPEED IS REGIONALLY QUANTIFIED IN MILES PER HOUR. WIND SPEED IS CONVERTED TO WIND PRESSURE IN PSF. THE TRIBUTARY AREA FOR EACH STUD X THE WIND PRESSURE IS THE RESISTANCE REQUIRED OF EACH STUD. (c6.8) RUNS COMPARISON NUMBERS ON THE STUD DEPTH AND SPACING TO VERIFY/QUANTIFY THIS SELECTION CRITERION.



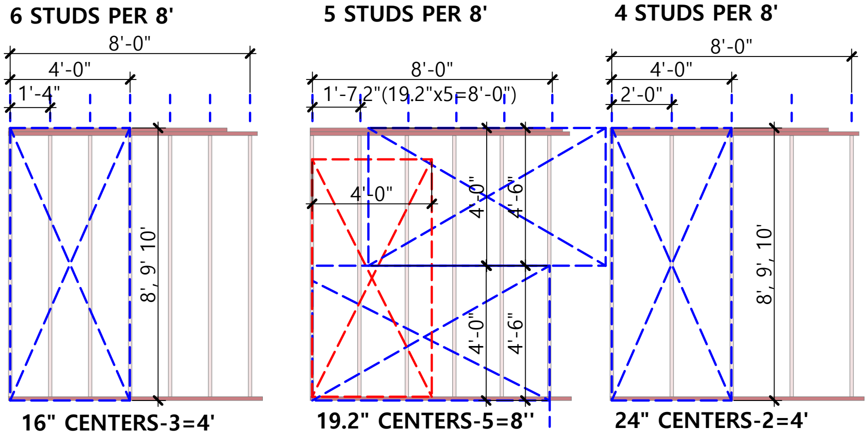
1 OR 2 TOP PLATES R602.3.2 & R602.3.3

***2 PLATE DEFAULT_**IT IS PESKY TO SWITCH BETWEEN 1 AND 2 PLATE INSTALLATIONS (STUD HTS ARE DIFFERENT) AND NORMAL FOR 1 METHOD TO BE CHOSEN AS A PROJECT DEFAULT. A DOUBLE TOP PLATE CONSTRUCTION IS MORE FORGIVING.
***1 PLATE_**IS ADVOCATED (ADVANCED FRAMING) BECAUSE IT DECREASES WOOD, INCREASES INSULATION. IT IS SIMPLY TRICKY TO PULL OFF WITHOUT GOOD PLANNING BECAUSE OF THE ALIGNMENT ISSUE. IT ALSO CAN DRIVE AN INEFFICIENCY IN SELECTED FRAMING CENTERS FOR ROOF AND FLOORS AND WALLS.
***DETAILS_**THERE ARE ATTENDING CONDITIONS FOR BOTH CONSTRUCTIONS NOTED IN THE CODE SECTIONS.



CAVITY INSULATION

***INSULATION VALUE_**INSULATION PRODUCTS HAVE A HIGHER INSULATION VALUE THAN WOOD. LESS WOOD=MORE INSULATION=HIGHER ENERGY EFFICIENCY. STUD SPACING HAS A SMALL IMPACT HERE.
***PERCENTAGES_**TOP NUMBERS SHOW SIMPLE PERCENTAGE PER THESE ILLUSTRATIONS. LOWER NUMBER IS AN ACTUAL R-VALUE (REDUCTION) FACTOR FOR WALL ASSEMBLIES (c6.17). SEE THE BIGGER THERMAL ENVELOPE PICTURE(c9).
***MATERIALS_**SPRAY/LOOSE INSULATION WORKS EQUALLY IN ANY CAVITY WIDTH. BATTS ARE NOT SO READILY AVAILABLE FOR 19.2 CENTERS IN STANDARD WALL THICKNESSES.



SHEETROCK EFFICIENCY

***BOARD SIZE AND ORIENTATION_**INSTALLERS MAY HAVE A PREFERENCE BUT THE GENERAL GOAL IS TO MINIMIZE BUTT JOINTS
***VERTICAL ORIENTATION_** 4X8 FOR 8' CEILINGS, 4X9 FOR 9' CEILINGS, 4X10 FOR 10' CEILINGS. WORTH ORDERING THE RIGHT HEIGHT BOARD.
***HORIZONTAL ORIENTATION_** 2 HORIZONTAL RUNS OF 4X BOARD WORKS WITH 8' CEILINGS. 2 HORIZONTAL RUNS OF 4'-6" BOARD WORKS WITH 9' CEILINGS. TO MINIMIZE JOINTS 10,12,14,16 LENGTHS AVAILABLE.

CODE CHARTED LOAD LIMITS ON FRAME WALLS

TABLE R602.3(5) SIZE, HEIGHT AND SPACING OF WOOD STUDS[a]

STUD SIZE (inches)	BEARING WALLS: Laterally unsupported stud height[a] (feet)	BEARING WALLS: Maximum spacing when supporting a roof-ceiling assembly or a habitable attic assembly, only (inches)	BEARING WALLS: Maximum spacing when supporting one floor, plus a roof-ceiling assembly or a habitable attic assembly (inches)	BEARING WALLS: Maximum spacing when supporting two floors, plus a roof-ceiling assembly or a habitable attic assembly (inches)	BEARING WALLS: Maximum spacing when supporting one floor height[a] (feet)	NONBEARING WALLS: Laterally unsupported stud height[a] (feet)	NONBEARING WALLS: Maximum spacing (inches)
2 × 3[b]	—	—	—	—	—	10	16
2 × 4	10	24[c]	16[c]	—	24	14	24
3 × 4	10	24	24	16	24	14	24
2 × 5	10	24	24	—	24	16	24
2 × 6	10	24	24	16	24	20	24

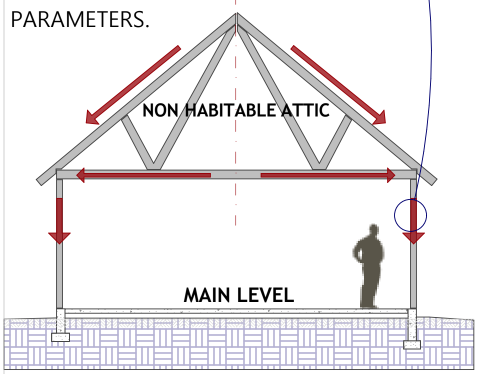
GRAVITY LOADS ACCUMULATE

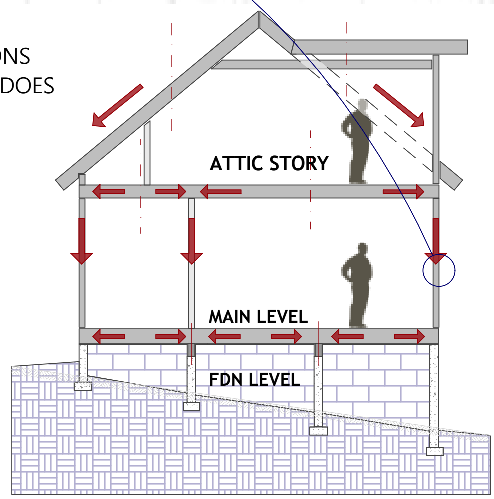
***SIMPLE MATH**_TOTAL LOADS ACCUMULATE FROM THE ROOF DOWN. THEREFORE THE REQUIREMENTS FOR STUD WALLS SUPPORTING THAT INCREASED LOAD BECOME GREATER.

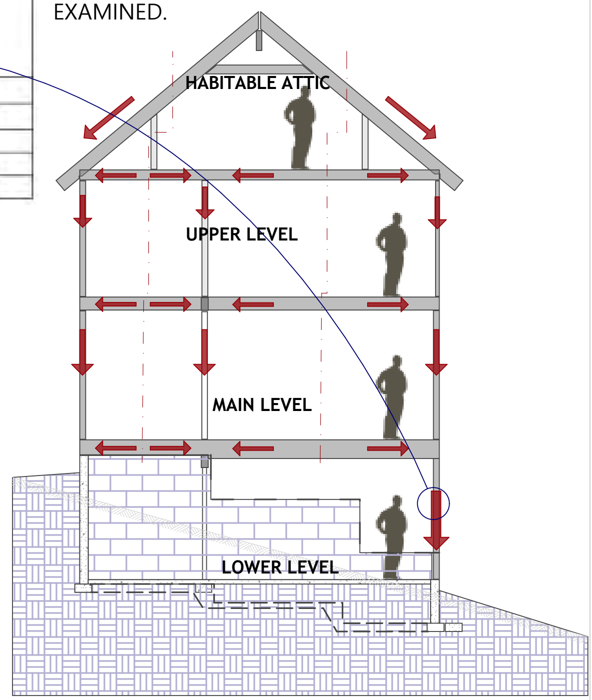
***CODE CHART**_ILLUSTRATES AND CONFIRMS THIS. NOTE , AS WITH ALL CODE CHARTS, THERE ARE FOOTNOTES & CONDITIONS THAT NEED TO BE EXAMINED.

CODE ASSUMPTIONS

***CODE CHARTS**_SHOWS SPACING/PERMISSIONS FOR STUDS 10'H (OR LESS). BUT THIS CHART DOES NOT SPECIFY GRAVITY OR WIND LOADING PARAMETERS.

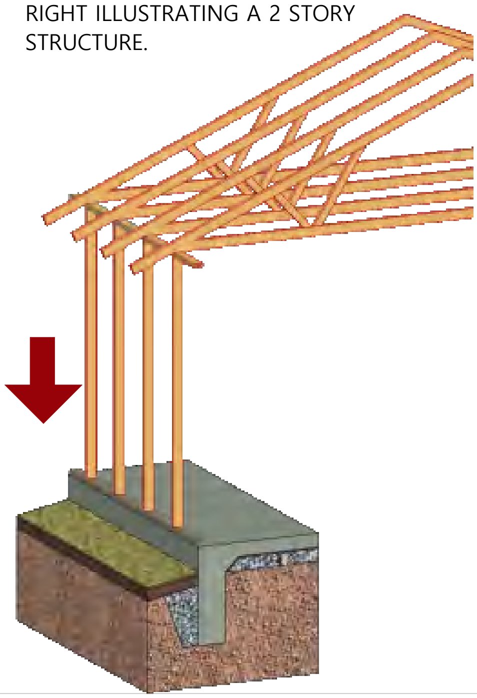






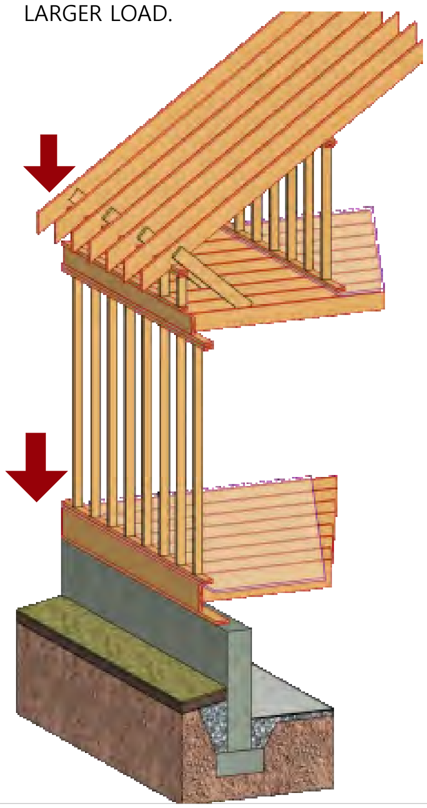
REAL LOADS

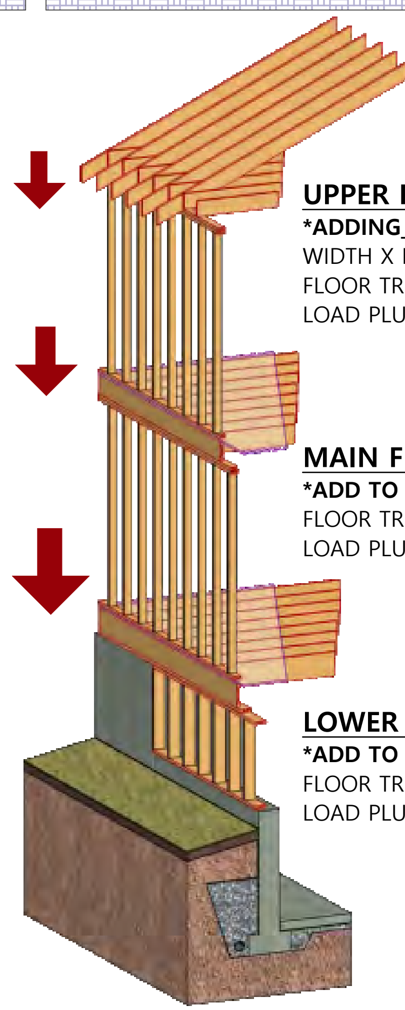
***ONE STORY**_SIMPLE. STUD WALL CARRYING HALF THE ROOF SPAN. THIS TRUSS ROOF COULD BE SPANNING A 20' WIDE STRUCTURE, OR A 40' WIDE STRUCTURE. THE LOAD IS COMPLETELY CONTINGENT ON THAT TRIBUTARY AREA (AND THE SNOW LOAD). THIS LOAD MAY BE GREATER THAN THE LOADING ON THE EXAMPLE TO THE RIGHT ILLUSTRATING A 2 STORY STRUCTURE.



REAL LOADS

***TWO STORY**_THIS ROOF AND UPPER STORY IMPOSES A LARGER LOAD ON THE FRONT WALL THAN THE BACK WALL BASED ON TRIBUTARY AREA. THE WALL NEEDS TO BE SIZED FOR THE LARGER LOAD.





UPPER FLOOR WALL

***ADDING**_ROOF TRIBUTARY WIDTH X LOAD PLUS ATTIC FLOOR TRIBUTARY WIDTH X LOAD PLUS WALL DEAD LOAD.

MAIN FLOOR WALL

***ADD TO THE ABOVE**_UPPER FLOOR TRIBUTARY WIDTH X LOAD PLUS WALL DEAD LOAD.

LOWER FLOOR WALL

***ADD TO THE ABOVE**_MAIN FLOOR TRIBUTARY WIDTH X LOAD PLUS WALL DEAD LOAD.

CALCULATED LOAD LIMITS ON FRAME WALLS

THE NUMBERS ARE INSTRUCTIVE

***COMPUTER CALCS**_ALL CALCS BELOW ARE DONE USING A SOFTWARE PACKAGE THAT, LIKE ALL SUCH SOFTWARE, CLOSELY FOLLOWS ENGINEERING FORMULAS AND DOES THE MATH ACCURATELY. IF INPUT IS ACCURATE, OUTPUT IS ACCURATE.

***CODE CHART CONTRADICTIONS**_THE 2 SAMPLE EXERCISES SHOW A SPECIFIC GRAVITY LOAD AND AN ASSUMED LATERAL WIND LOAD (OF 13.8 psf). THIS SHEET GIVES PASS/FAIL MARKS BY PERCENTAGE OR SUCCESS AND FAILURE ON BOTH GRAVITY AND LATERAL LOADS. ENGINEERING REFERS TO THIS AS 'COMBINED STRESS FACTOR'. THIS CALCULATION EXERCISE IS INTENDED ONLY TO ILLUSTARTE DIFFERENCES IN STUD HT, CENTERS, FOR 2X4 AND 2X6, AND WOOD SPECIES.

ADD THE NUMBERS

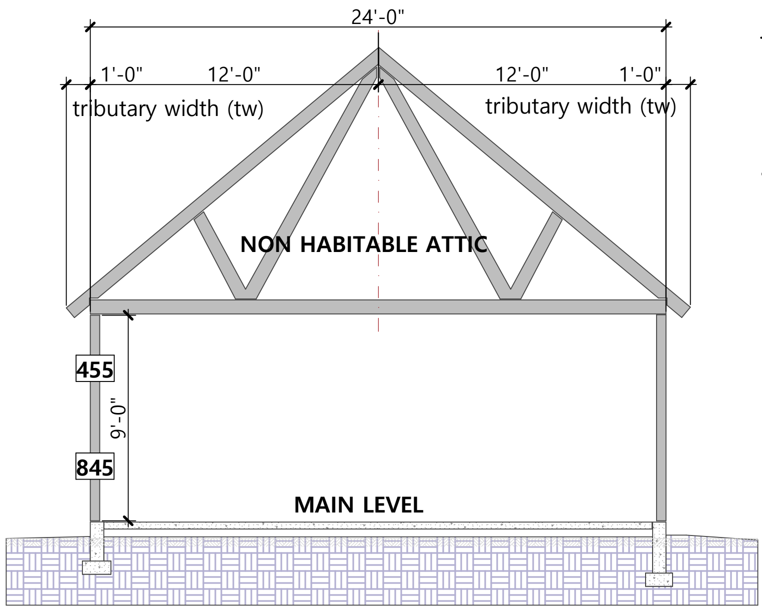
*BELOW AN 'ADD UP THE LOAD' EXERCISE SIMILAR TO (c6.6) WITH NUMBERS INCLUDED.

*SO IN A GIVEN PROJECT THERE ENDS UP BEING SEVERAL TO MANY DIFFERENT LOAD CONDITIONS ON THE FRAME WALLS. BEST TO UNCOVER THE MOST LOADED CONDITION AND SET THAT SOLUTION AS THE PROJECT FRAME WALL STANDARD.

EXTERIOR BEARING WALLS:
(EACH SIDE EQUAL)

ROOF LOAD_13'TW x 35#=455 PLF
(20 PSF ROOF LIVE LOAD)
MAIN WALL LOAD TOTAL_455 PLF

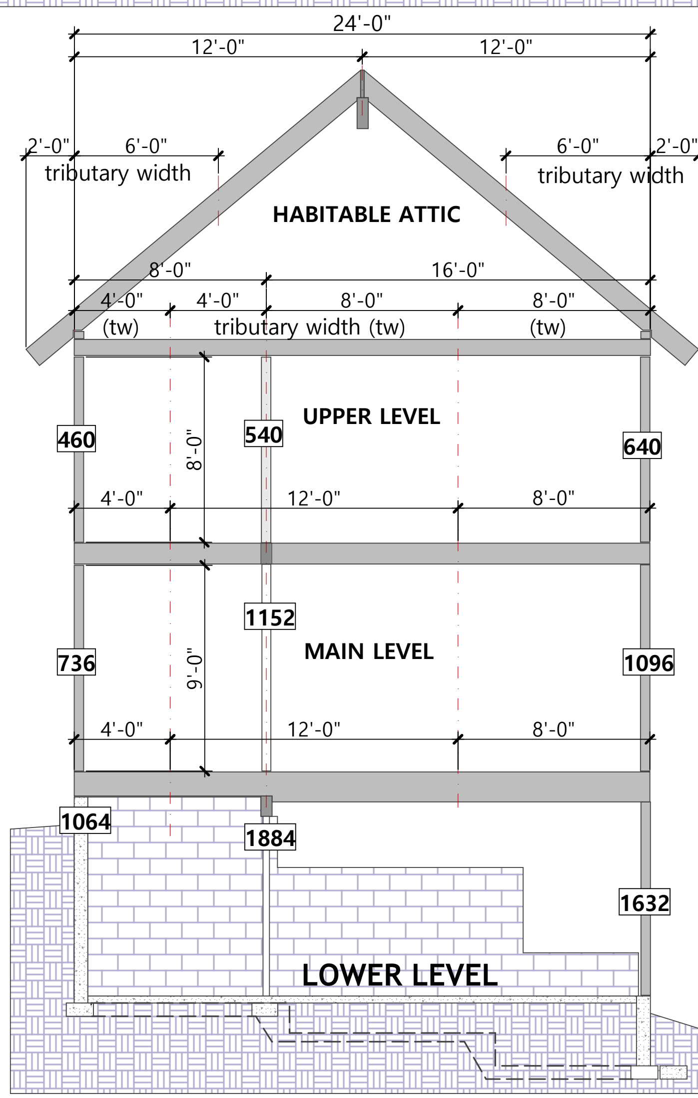
ROOF LOAD_13'TW x 65#=845 PLF
(50 PSF ROOF LIVE LOAD)
MAIN WALL LOAD TOTAL_845 PLF



EXTERIOR BEARING:(RT SIDE)
ROOF LOAD_8'tw x 35#=280 PLF
ATTIC FL LOAD_8'tw x 45#=360 PLF
UPPER WALL LOAD TOTAL_640 PLF
UPPER WALL DL_8'H X 12 PSF=96 PLF
UPPER FLOOR_8'tw x 45#=360 PLF
MAIN WALL LOAD TOTAL_1096 PLF
MAIN WALL DL_8'H X 12 PSF=96 PLF
MAIN FLOOR_8'tw x 55#=440 PLF
LOWER WALL LOAD TOTAL_1632 PLF

EXTERIOR BEARING:(LEFT SIDE)
ROOF LOAD_8'tw x 35#=280 PLF
ATTIC FL LOAD_4'tw x 45#=180 PLF
UPPER WALL LOAD TOTAL_460 PLF
UPPER WALL DL_8'H X 12 PSF=96 PLF
UPPER FLOOR_4'tw x 45#=180 PLF
MAIN WALL LOAD TOTAL_736 PLF
MAIN WALL DL_9'H X 12 PSF=108 PLF
MAIN FLOOR_4'tw x 55#=220 PLF
LOWER WALL LOAD TOTAL_1064 PLF

CENTER BEARING:
ROOF LOAD_NA
ATTIC FL LOAD_12'tw x 45#=540 PLF
UPPER WALL LOAD TOTAL_540 PLF
UPPER WALL DL_8'H X 9 PSF=72 PLF
UPPER FLOOR_12'tw x 45#=540 PLF
MAIN WALL LOAD TOTAL_1152 PLF
MAIN WALL DL_8'H X 9 PSF=72 PLF
MAIN FLOOR_12'tw x 55#=660 PLF
LOWER WALL LOAD TOTAL_1884 PLF



REAL WALL LOADING

CLEAR OBSERVATIONS

1. WALL HEIGHT MATTERS
2. STUD CENTERS MATTER
3. SPECIES AND GRADE MATTER
4. 2X6 @ 24" OC IS CONSIDERABLY 'STRONGER' THAN 2X4 @ 16" OC
5. TRIBUTARY WIDTH AND SNOW LOADS ARE THE 2 MOST SIGNIFICANT LOAD VARIABLES

SAMPLE CALCS/STUD WALL

***GRAVITY LOAD=1000 PLF**
LATERAL WIND LOAD=5 PSF
***STRONG AXIS BRACING=0** **
*DEFAULT MINIMUM SETTING FOR WIND
**STRONG AXIS BRACING IS ONE OF THE (MANY) STRUCTURAL VARIABLES THAT GETS SET IN A CALCULATION THAT DOES NOT ALWAYS REPRESENT A REAL CONDITION. WITH THIS SET AT ZERO THESE CALCS ARE MORE STRINGENT THAT CODE PERMISSIONS. THE VALUE OF THIS EXERCISE IS IN COMPARING 2X4/2X6, WALL HTS AND CENTERS.

STUD GRADE SPRUCE PINE FIR (SPF)
8'H*2X4 SPF @ 16" PASSES BY 37%
8'H*2X4 SPF @ 24" FAILS BY 13%

9'H*2X4 SPF @ @16 PASSES BY 24%
9'H*2X4 SPF @ 24" FAILS BY 138%

10'H*2X4 SPF @ 16" FAILS BY 26%
10'H*2X4 SPF @ 24" FAILS BY 833%

8'H*2X6 SPF @ 16" PASSES BY 74%
8'H*2X6 SPF @ 24" PASSES BY 61%

9'H*2X6 SPF @ 16" PASSES BY 71%
9'H*2X6 SPF @ 24" PASSES BY 57%

10'H*2X6 SPF @ 16" PASSES BY 69%
10'H*2X6 SPF @ 24" PASSES BY 52%

SAMPLE CALCS

***GRAVITY LOAD=1000 PLF**
***LATERAL WIND LOAD=5 PSF**
***STRONG AXIS BRACING=0**
***9'H wall 2X4 'stud' grade @ 16" OC**
SEE NOTE ABOVE. THIS SAMPLE CALC INTENDED TO ILLUSTRATE THE DIFFERENCE IN SPECIES BEHAVIOR ONLY.

*EASTERN SOFTWOODS- FAILS BY 67%
*SPRUCE-PINE-FIR- PASSES BY 24%
*HEM-FIR- PASSES BY 24%
*SOUTHERN PINE- PASSES BY 26%
*DOUGLAS FIR-LARCH- PASSES BY 34%

WIND LOAD SIMPLIFIED-SEE (c8) FOR WIND CHECKS AND CONCERNS

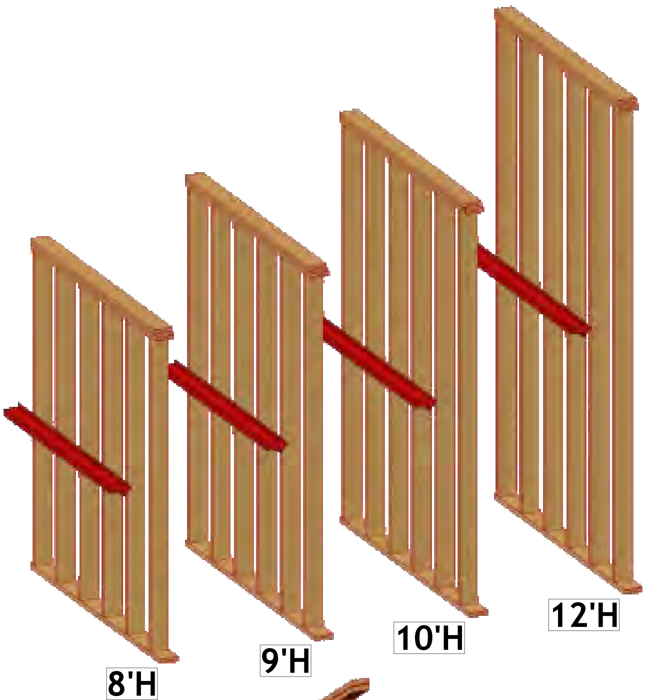
***WIND ZONES_** ULTIMATE DESIGN WIND SPEED FOR MOST OF THE USA IS 115 MPH. THE EASTERN & GULF SEABORDS ARE (CONSIDERABLY) HIGHER AS ARE SOME SPECIFIC LOCATIONS IN THE WESTERN MOUNTAINS.

***WIND SPEED TRANSLATES TO WIND PRESSURE_**THE CALCS IN THIS **COMPARATIVE** ILLUSTRATION IS USING A TRANSLATED WIND SPEED TO PRESSURE LOAD OF 13.8 PSF. THIS LOAD SELECTION IS REASONABLE, BUT SO CONDITIONAL ON REAL SITE FACTORS THAT IT MAY BE CONSIDERED RANDOM. SO IT IS EMPHASIZED WE LOOK AT ALL THESE PERFORMANCE RESULTS AS A **COMPARATIVE** EXERCISE ONLY.

***SAME RESISTANCE VARIABLES APPLY_**VERTICAL STUDS RESISTING LATERAL WIND LOADS SHARES THE SAME DEFLECTION THINKING AS BEAMS AND JOISTS RESISTING GRAVITY LOADS. SHORTER SPANS (STUD LEGTHS), CLOSER SPACING, DEEPER MEMBERS WILL PERFORM BETTER.

***THE DEFLECTION LIMITS NUMBERS_TABLE R301.7_**L/180 IS THE CODE LIMIT ON WALL CONSTRUCTION WITH GWB INTERIOR FINISH. FOR "BRITTLE" EXTERIOR FINISHES THE REQUIREMENT IS MORE STRINGENT AT L/240. (NOTE H- HEIGHT OF WALL, AND L- LENGTH OF STUD, IS THE SAME.)

***TALL WALL DEFLECTION LIMITS_**MAY ALLOW MORE ACTUAL DEFLECTION THAN WANTED. ALONG WITH BRITTLE FINISHES (ANY MATERIAL PRONE TO CRACKING), WINDOWS- PARTICULARLY TALL ONES- ARE A CONCERN. KING STUD(S) ARE DOING SOME IMPORTANT WORK IN THESE INSTANCES.



***'STUD' GRADE SPRUCE PINE FIR (SPF)**

8'H*2X4 SPF @ 16" PASSES L/364 .26"
8'H*2X4 SPF @ 24" PASSES L/243 .4"

9'H*2X4 SPF @ 16"PASSES L/256 .42"
9'H*2X4 SPF @ 24" FAILS L/170 .63"

10'H*2X4 SPF @ 16" PASSES L/186 .64"
10'H*2X4 SPF @ 24" FAILS L/124 .97"

8'H*2X6 SPF @ 16" PASSES L/1413 .07"
8'H*2X6 SPF @ 24" PAASES L/942 .10"

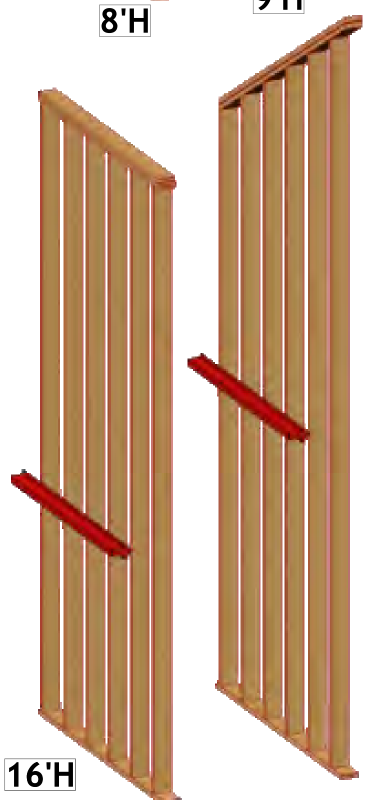
9'H*2X6 SPF @ 16" PASSES L/992 .11"
9'H*2X6 SPF @ 24" PASSES L/662 .16"

10'H*2X6 SPF @ 16" PASSES L/723 .17"
10'H*2X6 SPF @ 24" PASSES L/482 .25"

12'H*2X6 SPF @ 16" PASSES L/419 .34"
12'H*2X6 SPF @ 24" PASSES L/279 .52"

***COMPARATIVE DEFLECTION RESULTS USING A GRAVITY LOAD OF 1000 PLF AND A CONSISTENT 13.8 PSF HORIZONTAL WIND LOAD.**

1. HEIGHT, REPRESENTING THE SPAN, AND SPACING, DETERMINING THE TRIBUTARY WIDTH, BOTH EFFECT THE DEFLECTION.
2. THE STUD MEMBER (2X4/2X6) IS IN FACT A GREATER DETERMINANT. THE 2X6 STUD HAS 40% MORE 'DEPTH' TO RESIST THAT LATERAL WIND LOAD.
3. NOTE THE 2X6 WALL , AT ALL 3 STANDARD HTS, IS MORE EFFECTIVE AT A 24" SPACING THAN THE 2X4 STUD IS AT 16" SPACING.
4. SPECIES_DF-L AND SOUTHERN PINE ARE 2 SPECIES PERFORM MORE EFFECTIVELY RESISTING DEFLECTION.
5.THE TALLER 2X4 WALLS WANT TO BE VETTED. THEY ARE PERMITTED BY CODE (EXCEPT ON THE FIRST OF 3 FLOORS), BUT FAIL IN BOTH GRAVITY & WIND LOAD CATAGORIES IN THESE COMPARATIVE EXERCISES.



OTHER 'STUD' MEMBER OPTIONS FOR TALLER WALLS
#2 GRADE FOR 16' LENGTHS

16'H*2X6 SPF @ 8" PASSES L/482 .40"
16'H*2X6 SPF @ 12" PASSES L/321 .60"
16'H*2X6 SPF @ 16" PASSES L/241 .80"
16'H*2X6 SPF @ 19.2" PASSES L/201 .96"
16'H*2X6 SPF @ 24" FAILS L/254 1.39"

ENGINEERED STUDS TIMBERSTRAND LSL 1.3E 2X6 (1 3/4" X 5.5") ACTUAL

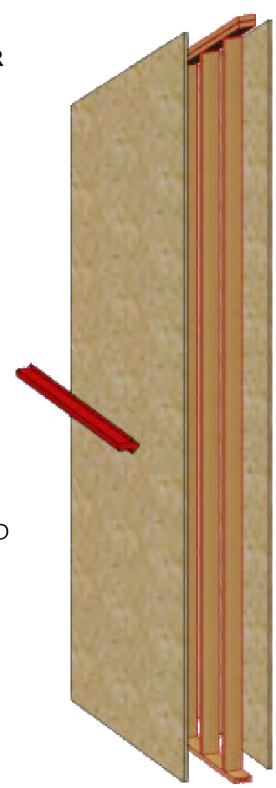
16'H* @ 8" PASSES L/482 .40"
16'H* @ 12" PASSES L/321 .60"
16'H* @ 16" PASSES L/241 .80"
16'H* @ 19.2" PASSES L/201 .96"
16'H* @ 24" FAILS L/138 .75"

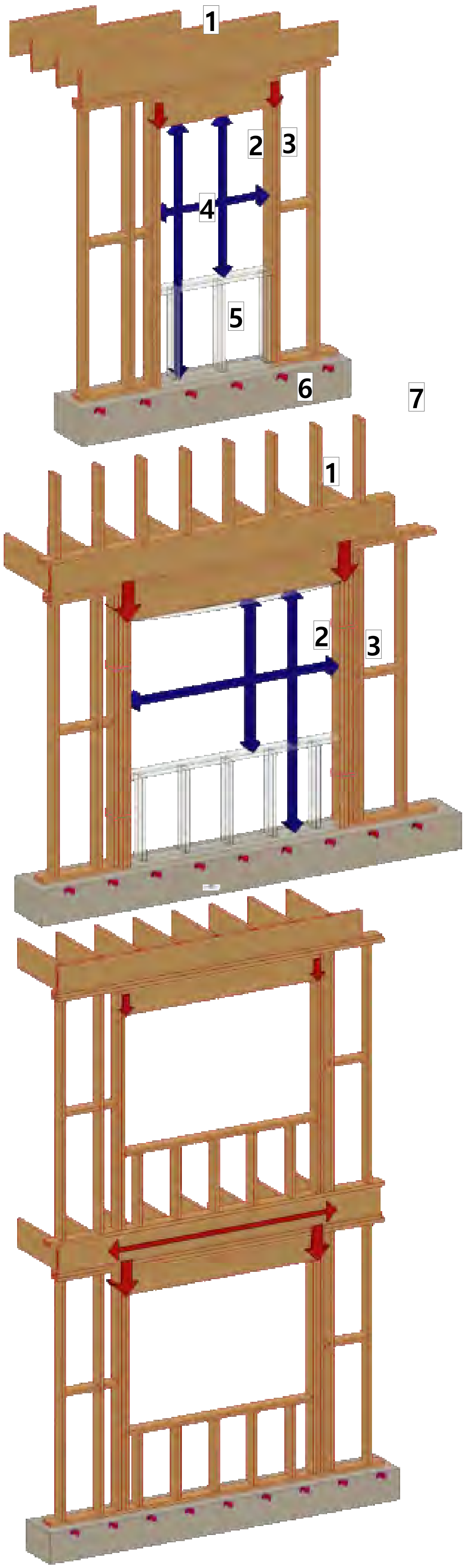
ENGINEERED STUDS MICROLAM LVL 2X6 (1 3/4" X 5.5") ACTUAL

16'H* @ 8" PASSES L/763 .25"
16'H* @ 12" PASSES L/509 .38"
16'H* @ 16" PASSES L/382 .50"
16'H* @ 19.2" PASSES L/318 .6"
16'H* @ 24" PASSES L/254 .75"

***COMPARATIVE DEFLECTION RESULTS FOR A 16' TALL WALL.**

* GRAVITY LOADING THIS EXERCISE WAS INCREASED A BIT FROM THE ABOVE EXERCISE.
1. CERTAINLY WHEN WALLS GETS OVER 10' HIGH THEY NEED TO BE MORE CAREFULLY SCRUTINIZED. HEIGHT, SPACING, DEPTH OF MEMBER REMAIN THE VARIABLE TO BE CONSIDERED.
2. STANDARD STUD GRADES WILL LIKELY NOT BE FOUND AT THESE LONGER LENGTH SO #2 GRADE BECOMES A DEFAULT. IT CAN BE HARD TO FIND STAIGHT 2X6'S IN THESE LONGER LENGTHS.
4. ENGINEERED MEMBERS ARE ALSO A CONSIDERATION. THE TALL WALLS ARE A CANDIDATE FOR SURE. THE ENGINEERED PRODUCTS ARE STRAIGHTER FOR SURE (AND HEAVIER).
5. BLOCKING WHICH WOULD BE REQUIRED THESE TALL WALLS FOR SEVERAL REASONS DOES NOT SHOW HERE.
6. OSB BOTH SIDES_IS A PRETTY SIMPLE WAY TO MAKE (ANY) WIND CHALLENGED WALL A LOT MORE RESISTANT.





HEADERS

***PURPOSE**_HEADERS FUNCTION AS BEAMS AND DIVERT GRAVITY LOADS FROM ABOVE TO ALLOW FOR OPENINGS IN THE WALL. HEADERS ARE NEEDED FOR DOOR AND WINDOW OPENINGS IN EXTERIOR WALLS AND DOOR AND PASSAGEWAY OPENINGS IN INTERIOR WALLS

***HEADER AS BEAM**_THE STRUCTURAL DEMANDS ON THESE SHORT BEAMS VARY SIGNIFICANTLY AS LOADS WILL VARY SIGNIFICANTLY. SIZING HEADERS IS DISCUSSED AT LENGTH THESE NEXT PAGES.

NON BEARING/LIGHT LOAD HEADERS

1*'NON' BEARING CONDITIONS_PARALLEL FLOOR AND (OR ROOF) LOADING DISTRIBUTES LIMITED LOADS ON THE WALL AND THEREFORE ON THE HEADER.

2*JACK STUD_A SINGLE JACK STUD TYPICAL FOR NON BEARING & SHORT SPAN HEADERS

3*KING STUD_A SINGLE KING STUD TYPICAL FOR SAME CONDIITONS.

4*ROUGH OPENING_IS THE FRAME OPENING AS REQUIRED BY THE DOOR OR WINDOW BEING INSTALLED. THE DESIRED HEAD HT NEEDS TO BE KNOWN.

5*SILL & CRIPPLES_REQUIRED FOR WINDOWS AND SHOWN THIS WAY TO ILLUSTRATE SIMILARITY OF THE HEADER CONDITION FOR DOORS AND WINDOWS.

6*CENTERS_CENTERS SET FOR THE FRAME WALLS ARE TYPICALLY 'RUN THRU' THE OPENING. THESE CENTERS ARE MAINTAINED PRIMARILY TO MAINTAIN THE NAILING/JOINING LOCATIONS FOR SHEETGOODS-OSB AND OR GWB.

BEARING/HEAVIER LOAD HEADERS

1*BEARING CONDITIONS_ACTUAL LOADING CAN VARY SIGNIFICANTLY. ACCURATE LOADING SUMMARIES REQUIRE WALL LOAD CALCS CONSIDERING TRIBUTARY WIDTHS AND ACUUMULATIVE LOADS FROM FLOORS ABOVE.

2*JACK STUDS_SEE (c6.9) FOR RULES OF THUMB ON THESE SUPPORTING JACK STUDS. 1 JACK STUD TYPICALLY OK FOR OPENINGS UP TO 5' OR 6'. 2 JACK STUDS ARE USUALLY FINE FOR OPENINGS UP TO 8' OR 9'. WIDER OPENINGS BEG CALCULATIONS.

3*KING STUDS_KING STUDS ARE DOING 2 DIFFERENT JOBS. THE SIMPLE ONE IS HOLDING THE HEADER AND JACK TOGETHER AS AN FINCTIONING ENTITY. THE OTHER IS RESISTING WIND LOAD. LOGIC SAYS ON INTERIOR SITUATIONS WIND LOADS ARE NOT AN ISSUE SO SINGLE KINGS ARE FINE EVEN IF LOADING DEMANDS MULTIPLE JACK STUDS. FOR EXTERIOR KINGS WIND LOADS DO NEED TO BE CONSIDERED.

***REALLY BIG OPENINGS**_FOR EXAMPLE-12' OR 16' WIDE OPENINGS FOR SLIDING GLASS DOOR UNITS, AND 16' OR 18' GARAGE DOOR OPENINGS DO REQUIRE SPECIAL ATTENTION. MANAGING DEFLECTION IS IMPORTANT. SLIDING DOORS DO NOT WANT ANY PRESSURE FROM A HEADER TOUCHING THE UNIT'S FRAME. GARAGE DOOR OPENINGS PHYSICALLY CAN SAG/DEFLECT WITHOUT INTERFERING WITH THE DOOR'S OPERATION BUT THEY ARE VISUALLY UNSETTLING AS BIGGER DEFLECTIONS BECOME NOTICEABLE.

STACKED HEADERS

***LOAD DIVERSION**_IS CHARACTERISTIC OF STACKED HEADERS.

***STACKED OPENINGS**_BY VIRTUE OF BEING STACKED HEADERS MOVE LOADS TO THE JACKS & FOLLOW VERTICALLY DOWNWARD & THEREFORE LOADING ON THE LOWER OPENINGS IS **NOT** ACCUMULATIVE.

***EXTERIOR HEADER SIZES**_SO LOWER LEVEL HEADERS IN STACKED CONDITIONS ARE RESPONSIBLE ONLY FOR THAT FLOORS LOADING DEMANDS.

JACKS & KINGS

***LOAD ACCUMULATION**_THE JACKS BECOME COLUMNS THAT ACCUMULATE THE DIVERTED LOADING FROM ABOVE. JUST BECAUSE OF THE CONNECTIONS AND PROXIMITY THE KINGS SHARE SOME OF THAT ACCUMULATED GRAVITY LOAD.

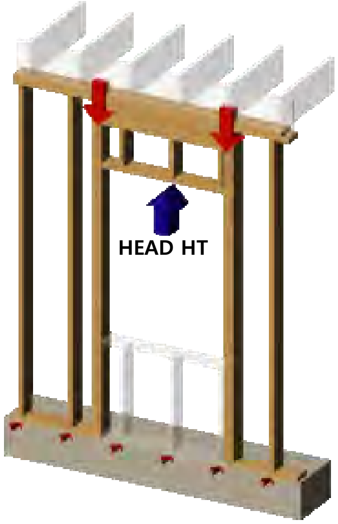
***GANGING**_WHEN JACKS AND KINGS GANG IN THESE SITUATIONS CODE WILL WANT THEM TO BE STRAPPED OR SOLIDLY BLOCKED SO THEY FUNCTION AS 1 COLUMN.

***OVERDONE**_HAVING STATED A CONCERN WITH BEING SURE THESE ACCUMULATIVE LOADS ARE ACCOUNTED FOR ONE CAN OVERDO THE NUMBER OF STUDS. IT HAPPENS ALL THE TIME. IT IS A VIOLATION OF THE LESS WOOD/MORE INSULATION ADVANCED FRAMING DIRECTIVE. THE BETTER SOLUTION IS TO HAVE THE JACKS AND KINGS 'CALCULATED'.

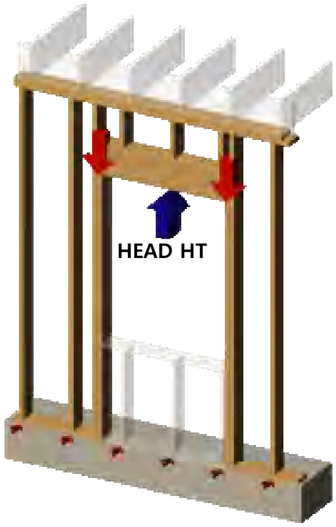
***OR ELIMINATE THE JACKS**_BY HANGING THE HEADER ON THE KINGS WITH A HANGER. HANGERS ARE PRETTY READILY AVAILABLE AND ARE RATED PER THEIR LOAD CARRYING CAPACITY.

***LATERAL LOAD**_JACKS ARE A BENEFIT TO THE KING STUD(S) IN RESISTING WIND LOAD, BECAUSE THEY STIFFEN THE CENTER SPAN AREA OF THE KING. IF A KING CONDITION IS BEING SIZED FOR THE WIND CONDITION THE JACK MAY NOT BE A LUMBER LIABILITY.

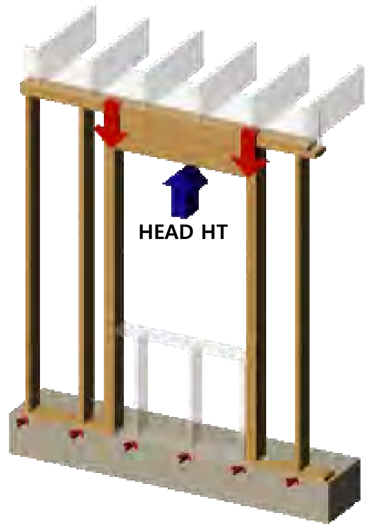
FRAME WALLS c6.10
HEADER CONFIGURATIONS 1



TIGHT TO PLATE



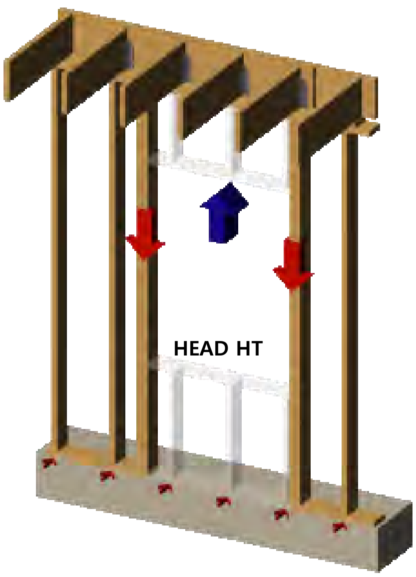
CONVENTIONAL



NO CRIPPLES

HEADER POSITIOING

***STRUCTURALLY**_THE HEADER AND THE SUPPORTING JACKS DO THE WORK. WHERE THE HEADER IS POSITIONED DOES NOT MATTER FROM THE GAVITY LOAD CONCERN. THE JACK STUD MUST GO FROM HEADER TO THE BOTTOM PLATE OR FLOOR AND NOT BROKEN AT A WINDOWS SILL PLATE. THE JACK STUD ALSO HELPS WITH VERTICAL STIFFNESS (RESISTING WIND LATERAL LOADS).
***CLEARANCE**_THE CEILING HT IS SET AND THE DESIRED WINDOW OR DOOR HEAD HT IS KNOWN. THIS LEAVES A SET NUMBER OF INCHES TO WORK WITH. IF THERE IS ENOUGH SPACE THE REQUIRED HEADER AND CRIPPLES WILL FIT. IF THAT SPACE IS TIGHT THEN A SELECTION STRATEGY NEEDS THOUGHT.
***EXAMPLES**_SEE (c6.10) FOR COMMON DIMENSIONAL CONDITIONS.



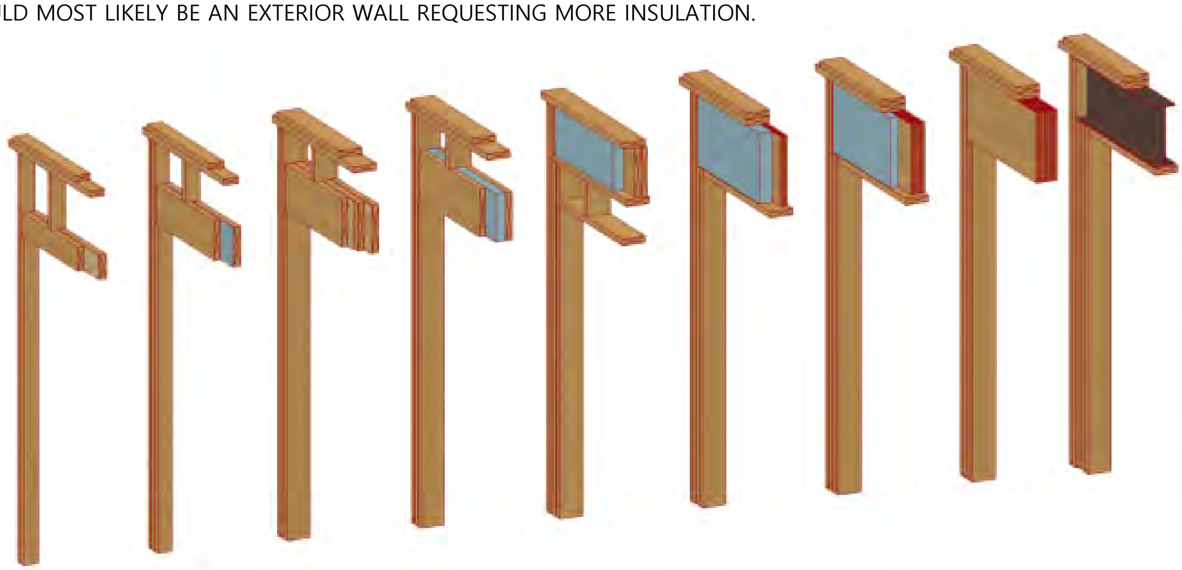
NON CONVENTIONAL HEADERS

***CONVENTIONAL RIM MEMBER**_PHYSICALLY FLOOR JOISTS ARE FRAMED ON TOP OF THE WALL PLATE AND FLUSH WITH THE RIM MEMBER. NORMALLY THE RIM MEMBERS PRIMARY JOB IS KEEPING THE JOISTS STRAIGHT & UPRIGHT- AND CARRYING SOME GRAVITY LOAD FROM PLATE ABOVE TO PLATE BELOW.
***RIM MEMBER IS THE BEAM/HEADER**_IF JOISTS ARE TIED TO THE RIM MEMBER WITH HANGERS OR A LEDGER THEN THE JOISTS ARE STRUCTUALLY SUPPORTED AS IF THE RIM MEMBER WERE A FLUSH BEAM. THE SPAN CAPACITY OF THAT RIM MEMBER ALLOWS A NUMBER OF STUDS TO JUST BE PULLED OUT AND THE RIM MEMBER SPANS FROM (REMAINING) STUD TO STUD. IF THE CONVENTIONAL RIM MEMBER IS A DOUBLE, A TRIPLE, OR AN LVL SELECTION, THEN THAT SPAN CAPACITY BETWEEN STUDS GETS INCREASINGLY LARGE. THIS TECHNIQUE IS CODE SANCTIONED. SEE FIGURE 602.7.2
***BENEFIT**_FULL INSULATION IS INSTALLED IN PLACE OF ALL HEADERS (WOOD) IN THE WALL PLANE. MORE INSULATION- LESS WOOD.
***PLATES_**THE TOP WALLS PLATES SHOULD BE INSTALLED AS IN ANY WALL SITUATION.
***RIM BEAM**_REGARDLESS OF CONFIGURATION, IT MUST NOT BE BROKEN OVER THE OPENING.
***NON CONVENTIONAL DESIGN OPTIONS_** ONE SPECIFIC POTENTIAL THIS AFFORDS IS CANTILEVERING RIM MEMBER BEAMS INTO A CORNER ALLOWING CORNER GLASS WITH MINIMAL TO NO CORNER SUPPORTS. ANOTHER IS BRINGING WINDOWS UP MUCH CLOSER TO THE CEILING LINE.

HEADER OPTIONS

***STRUCTURE**_FROM A DBL 2X4 UP TO STEEL BEAM. THE HEADER AS A DESIGNED BEAM CAN BE CALCULATED TO MANAGE LIGHT OR SERIOUS LOADS. ALWAYS REMEMBER THAT THE JACK AND KING VERTICAL SUPPORTS ARE CARRYING HALF THAT HEADER LOAD ON EACH SIDE, BECOME CONSIDERED POINT LOADS, AND NEED TO BE ACCOUNTED FOR ON FLOOR(S) BELOW.
***THE 3 1/2" WALL THICKNESS SANDWICH**_HEADER ASSEMBLY NEEDS TO BE MINDFUL OF THE FRAME WALL THICKNESS. THE CONVENTIONAL HEADER HAS 2-2X MEMBERS TOTALING 3" IN WIDTH LEAVING A HALF INCH FOR EITHER AN OSB FILLER OR A 1/2" RIGID INSULATION FILLER.
***THE 5 1/2" WALL THICKNESS SANDWICH**_HEADER ASSEMBLY WILL LEAVE SOME AMOUNT OF FILLER SPACE (EXCEPT 3 LVL MEMBERS THAT WILL EQUAL 5 1/4"). THE 2X6 WALL WOULD MOST LIKELY BE AN EXTERIOR WALL REQUESTING MORE INSULATION.

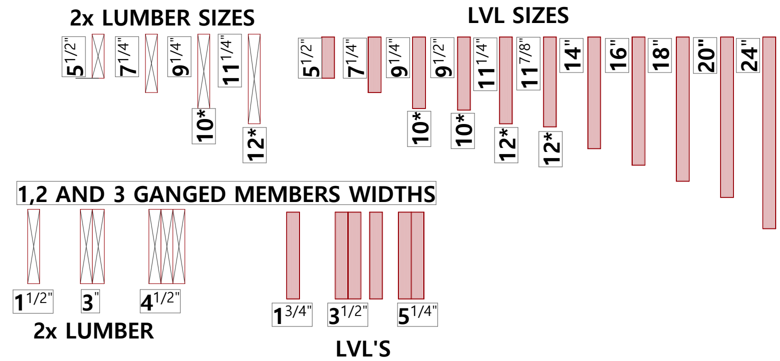
***SANDWICH OPTIONS**_PLACING ANY RIGID INSULATION IN THE MIDDLE HAS THE ADVANTAGE OF RETAINING FULL NAILING INTO THE HEADER BOTH SIDES FOR SHEETGOODS, DOOR+WINDOW TRIMS. BUT THE FRAMER MUST CREATE THE SANDWICH WHILE FRAMING. THE INSULATION CREW SHOWS UP LATER. ASSYMETRICAL HEADER SANDWICHES ARE TYPICALLY OK STRUCTURALLY BUT LEAVE A POSSIBLE NAILING PROBLEM ON THE INSULATION SIDE. NOTE 2X4 NAILERS SHOW THESE CONDITIONS AT BOTTOM OF HEADER. THE INSULATION WORKS THE SAME WHEREVER IT IS LOCATED.

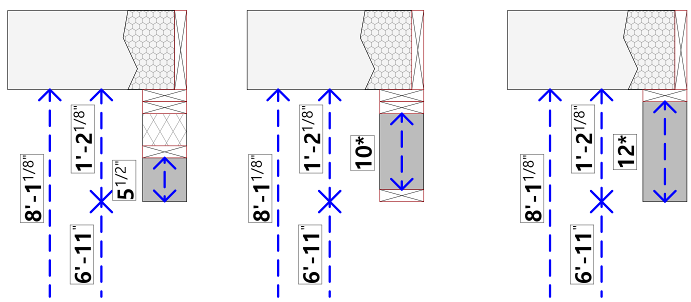


SPACING AND SIZING FOR HEADERS

***FITTING OPTIONS**_HEADERS ARE TYPICALLY FITTING VERTICALLY BETWEEN THE ESTABLISHED CEILING HEIGHT AND THE ROUGH OPENING REQUIRED OF A DOOR OR DESIRED OF A WINDOW. SO THERE IS A DEFINED NUMBER OF VERTICAL INCHES AVAILABLE FOR HEADER AND PLATE(S). BELOW ARE A MIXED BAG OF SITUATIONS THAT WILL AT LEAST SERVE TO INSPIRE ONE TO DO THE MATH FIRST TO MAKE SURE THEIR IS CLEARANCE.

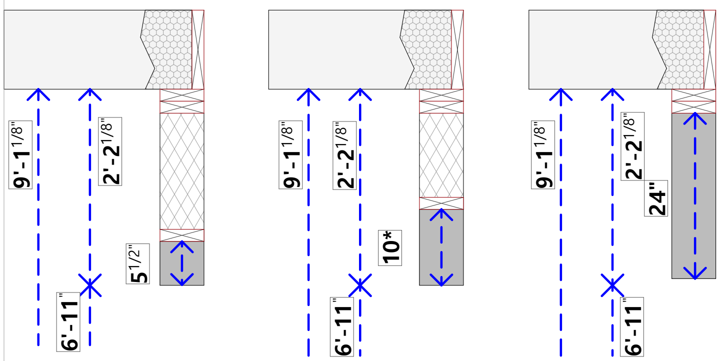
***PROPORTIONS**_REVISIT (c6.4) TO SEE HEADER HT AND CEILING HT RELATIONSHIPS.





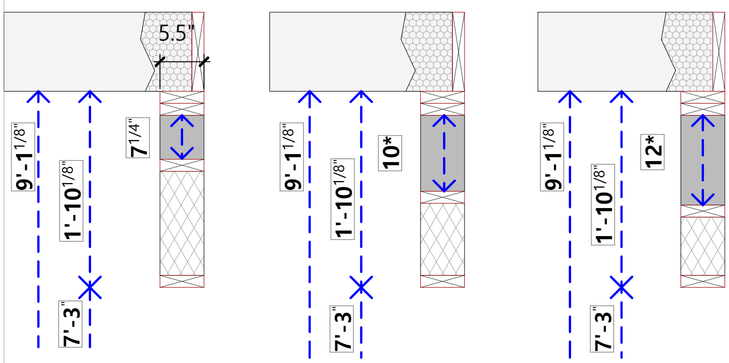
8' CEILINGS & 6'-11" RO HEADS

*THE ONLY CONFIGURATION FOR A 8' CEILING.
*THE 6'-11" HEADER IS FAIRLY STANDARD FOR EXTERIOR PATIO DOOR UNITS.
*THE INTERIOR 6'-8" STANDARD PANEL DOOR NEEDS A HEADER TYPICALLY 6'-10 1/2".



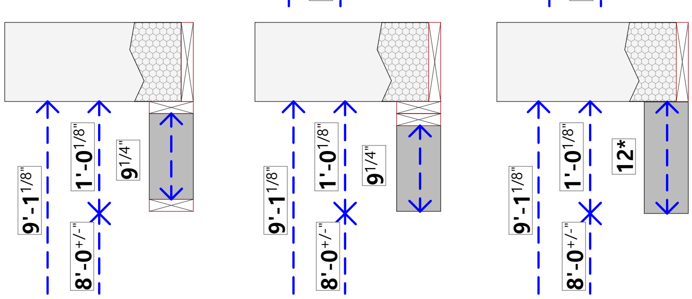
9' CEILINGS & 6'-11" RO HEADS

*THE MORE STANDARD CONFIGURATION FOR A 9' CEILING. NOT THE BEST PROPORTION AND MISSES AN OPPORTUNITY FOR TALLER EXTERIOR WINDOWS AND DOORS.
*SHOWS HEADER DOWN IN THE MOST CONVENTIONAL CONFIGURATION.
*ENOUGH CLEARANCE FOR ANY STRUCTURAL HEADER UP TO 24" DEEP LVL'S. (GARAGE DOOR OPENINGS CAN REQUIRE DEEP MEMBERS)



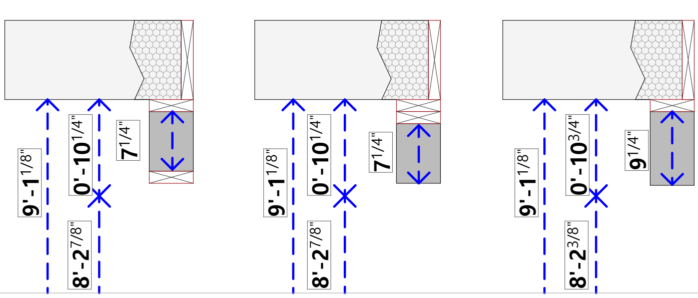
9' CEILINGS & 7'-3" RO HEADS

*THIS IS A GOOD DESIGN PROPORTION FOR 9 ' CEILINGS
*INTERIOR 7'H DOORS, WHICH HAVE BECOME READILY AVAILABLE, WILL WANT THE ROUGH OPENING CLOSER TO 7'-2 1/2".
*SOME MANUFACTURERS MAKE 7'-3" HINGED PATIO DOOR UNITS THAT THEN MAKE A GOOD CONSISTENT FIT.
*SHOWS THE HEADERS UP WITH CRIPPLES BELOW. THIS CONFIGURATION NOT GREAT FOR LARGER EXTERIOR OPENINGS FOR EXAMPLE 2 AND 3 PANEL GLASS DOORS.
*ENOUGH CLEARANCE FOR ANY STRUCTURAL HEADER.



9' CEILINGS & 8'-0" RO HEADS

*THIS CONFIGURATIONS SUGGESTING 8' EXTERIOR HEAD HT FOR 8' UNIT HT PATIO DOORS AND EXTERIOR WINDOWS. THIS IS NOT A GREAT PROPORTION BUT THE EXTRA GLASS AND VIEW HAS REAL VALUE.
*INTERIOR 7'H DOORS, WHICH HAVE BECOME READILY AVAILABLE, RECOMMENDED THIS SITUATION. 8' HIGH INTERIOR DOORS IN 9' CEILINGS LOOK CROWDED.



9' CEILINGS & 8'-3" RO HEADS

*THIS CONFIGURATION FOR FULL 8' DOOR PANEL HTS REQUIRING 8'-2 1/2" TO 8'-3" ROUGH OPENING. TIGHT, BUT THERE ARE HEADER OPTIONS.
*8' DOOR HTS WITH TRIM ABOVE GET DISPROPORTIONALLY CLOSE TO A 9' CEILING HT AND THEREEFORE THIS NOT REALLY RECOMMENDED.

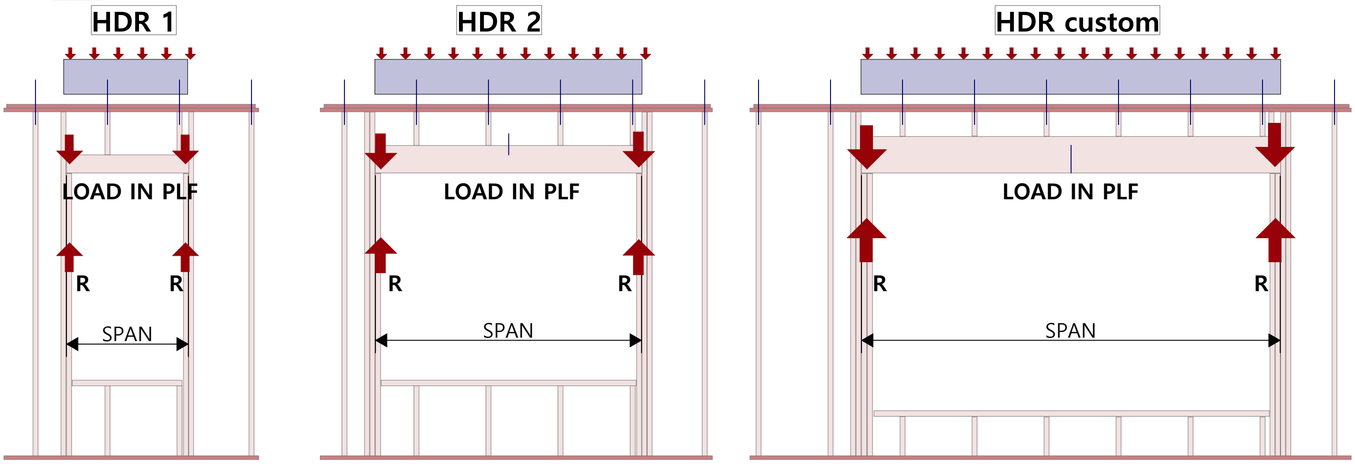
LOAD CRITERIA FOR HEADERS, JACKS, KINGS

3 HEADER CHECKS

*THE 3 ESSENTIAL CHECKS FOR HEADER PACKAGES ARE THE HEADER ITSELF (LOAD), THE JACK(S) (SUPPORTING THE LOAD), AND THE KING(S) TIEING THE PACKAGE TOGETHER AND RESISTING WIND LOADS.

CHECK 1_THE HEADER

*HEADER SIZING OPTIONS BASED ON LOAD IN PLF NEEDS FIRST TO BE DETERMINED.
*DETERMINING LOAD____

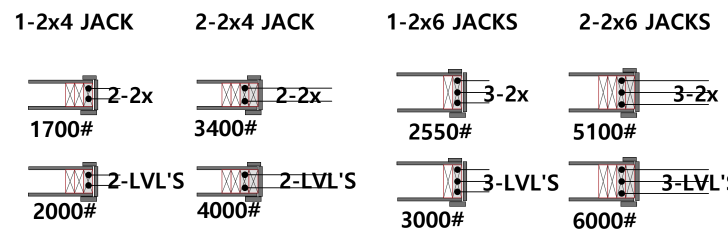


CHECK 2_LOAD ON THE JACK

***JACK LOAD=PLF X SPAN DIVIDED BY 2**

*LISTED ARE ACCEPTABLE LOADS FOR JACKS, AND IS CONSISTENT WITH INTERPOLATED ALLOWANCES IN THE CODE. THESE LOAD CAPACITIES END UP BEING MORE DEPENDENT ON BEARING LIMITATION (THE CRUSH FACTOR) OF 2X HEADERS, OR THE 2X UNDER HEADER PLATE, OR THE FLOOR PLATE THE JACK RESTS ON. THE STUDS THEMSELVES ARE CAPABLE OF SOME ADDITIONAL LOAD, PARTICULARLY THE 2X6 JACKS.

*THE SAME JACK SUPPORTING LVL'S CAN TAKE A BIT MORE LOAD AS THEY REPRESENT A BIT MORE BEARING AREA. THESE VALUES HAVE BEEN KICKED UP JUST A BIT TO GET THEM TO EVEN NUMBERS

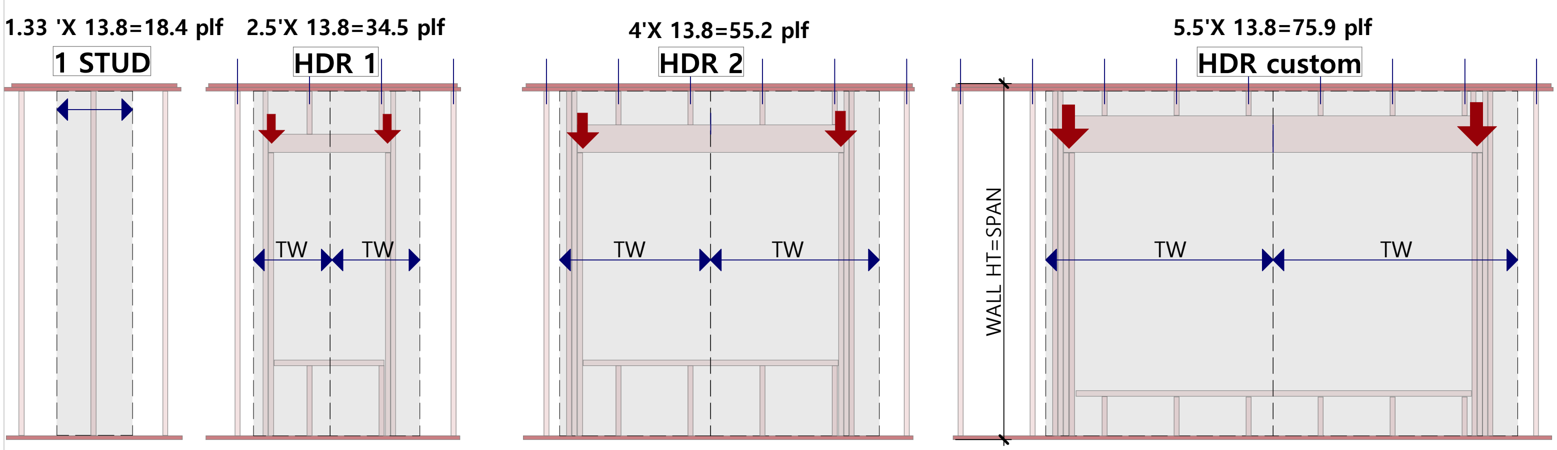


***UNIT BEARING VALUE_**THE LOAD CHART (c6.14) BREAKS DOWN THE BEARING CAPACITY, THEREFORE LOAD CAPACITY, BY 'UNIT'

CHECK 3_WIND LOAD ON THE KINGS

***WIND_**THE KINGS ARE THE PRIMARY VERTICAL BEAM RESISTING WIND LOAD. THE JACKS HELP OUT AS THEY STIFFEN THE KINGS AT THE MID SPAN. THE WIND LOAD IS A FUNCTION OF TRIBUTARY AREA AND LOCAL/CONDITIONAL WIND SPEED (PRESSURE). THE BIGGER THE WINDOW OR DOOR UNIT THE BIGGER THE PLF WIND LOAD.

***THESE LOAD TALLIES_**ARE USING 13.8 PSF FOR WIND PRESSURE. SPAN IS WALL HT =9'. TW IS 1/2 THE OPENING (3',6',9') PLUS HALF THE DISTANCE TO NEXT IN LINE STUD. THIS IS SHOWING HOW ONE CONSIDERS THE WIND LOADING ON THE KING/JACK ASSEMBLY. DO REMEMBER THAT THE KING/JACK IS KEEPING THE WINDOW (OR DOOR) UNIT STABLE.



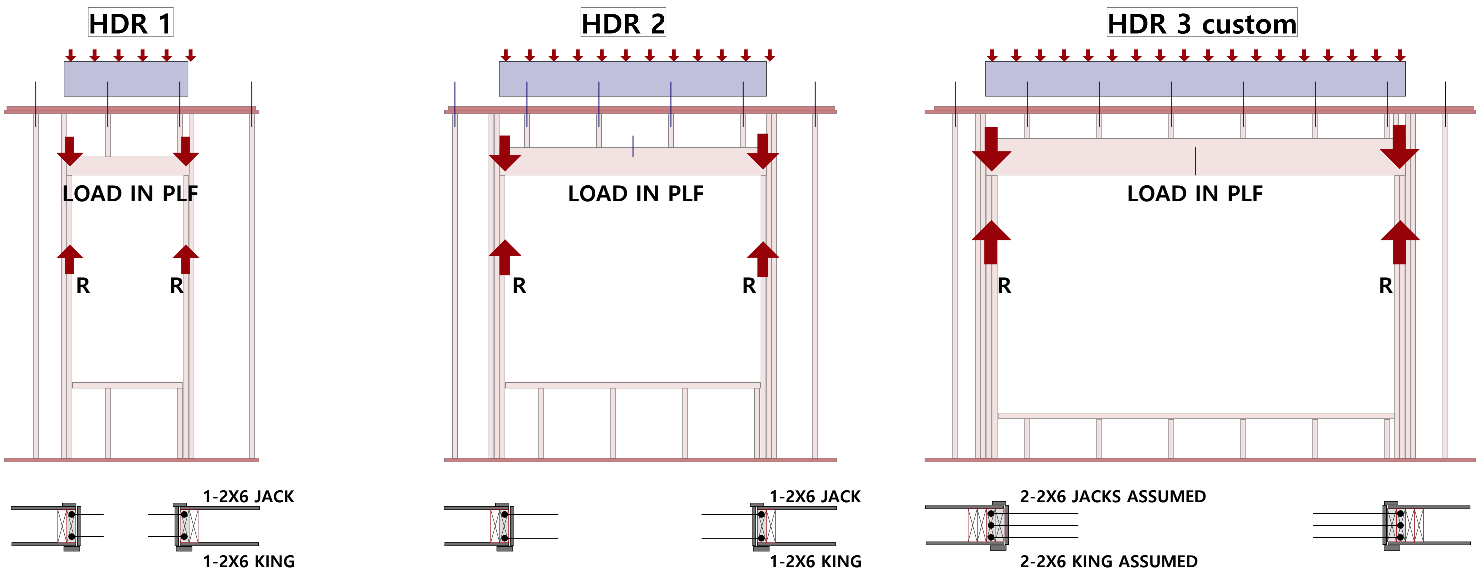
***THE DAMN PROBLEM WITH IDENTIFYING WIND PRESSURE_**SEE (c8). IDENTIFYING REAL WIND LOADS IS TOUGH ENOUGH. THE AVERAGED NUMBER USED IN THE FEW EXERCISES IS 13.8 PSF BUT THIS COULD BE ANYWHERE FROM 10.6 TO 19.0 JUST BASED ON THE THE STUD'S POSITION ALONG THE WALL, AND THE AREA OF THE WALL IT IS EMBEDDED IN. PINPOINTING A DEFINITIVE LOAD IS AT BEST FRUSTRATING.

***THE PROBLEM WITH TREATING KINGS AND JACKS LIKE BEAMS_**THESE STUDS ARE IN A WALL CONSTRUCTION AND ARE BEING ASSISTED BY THAT FULL SANDWICH WALL CONSTRUCTION. STANDARD CALCULATION SETTINGS DON'T ACCOUNT FOR THIS- ANY REALLY CAN'T BECAUSE THE VARIABLES JUST KEEP ADDING UP. SO BOTH LOADING AND THE STUD ASSEMBLY CAPACITY ARE IN QUESTION.

***THE RECOMMENDATION_**JACKS AND KINGS AS SELECTED FOR GRAVITY LOADING WILL SERVE THE WIND LOADING IN MOST CASES. THE 2X6 WALL WITH 2X6 KINGS AND JACKS PERFORMS CONSIDERABLY BETTER. LOOK FOR SITUATIONS WHERE THE STUDS ARE STANDING A LITTLE NAKED. ONE CONDITION IS CERTAINLY STUDS BETWEEN 2 BIGGER WINDOWS. THE TRIBUTARY WIDTH IS CAUSING A BIG LOAD AND THE STUDS ARE NOT GETTING ALL THAT MUCH COOPERATION FROM THE WALL CONSTRUCTION. THIS SITUATION IN A TALL WALL 2 STORY WALL REALLY WANTS ATTENTION. THESE SITATIONS MAY WANT TO BE 'DESIGNED'.

DEFAULT HEADERS

*BECAUSE OF THE VARIETY OF OPTIONS AND POSSIBLE CONFUSIONS THIS PROJECT HAS ELECTED TO THNK IN TERMS OF 3 HEADER TYPES AS A WAY TO KEEP THIS ARENA OF STRUCTURE REASONABLY SIMPLE.
*FOLLOW THE THINKING BEHIND THESE SELECTIONS AND IT ALL MAKES SENSE. THERE ARE EXCEPTIONS TO THESE LOADING PARAMETERS SO ONCE AGAIN KEEPING THINGS SIMPLE RUNS SOME RISK.
*BOTH 6" AND 10" HEADERS CAN FIT IN MOST CONFIGURATION CONDITIONS. (c6.11)
*2 PLYS ARE A CONSISTENT CRITERION IN ORDER TO ALLOW FOR A RIGID INSULATION SANDWICH. THERE MAY BE INSTANCES WHERE 3 PLY ARE REQUIRED STRUCTUALLY.
*LOWEST LEVEL IN 3 LEVEL CONSTRUCTION CAN PUSH THE STRUCTURAL LIMITS AND WANT TO BE CHECKED. ALSO CHECK FOR STACKED CONDITIONS THAT RELIEVE A LOT OF LOADING.



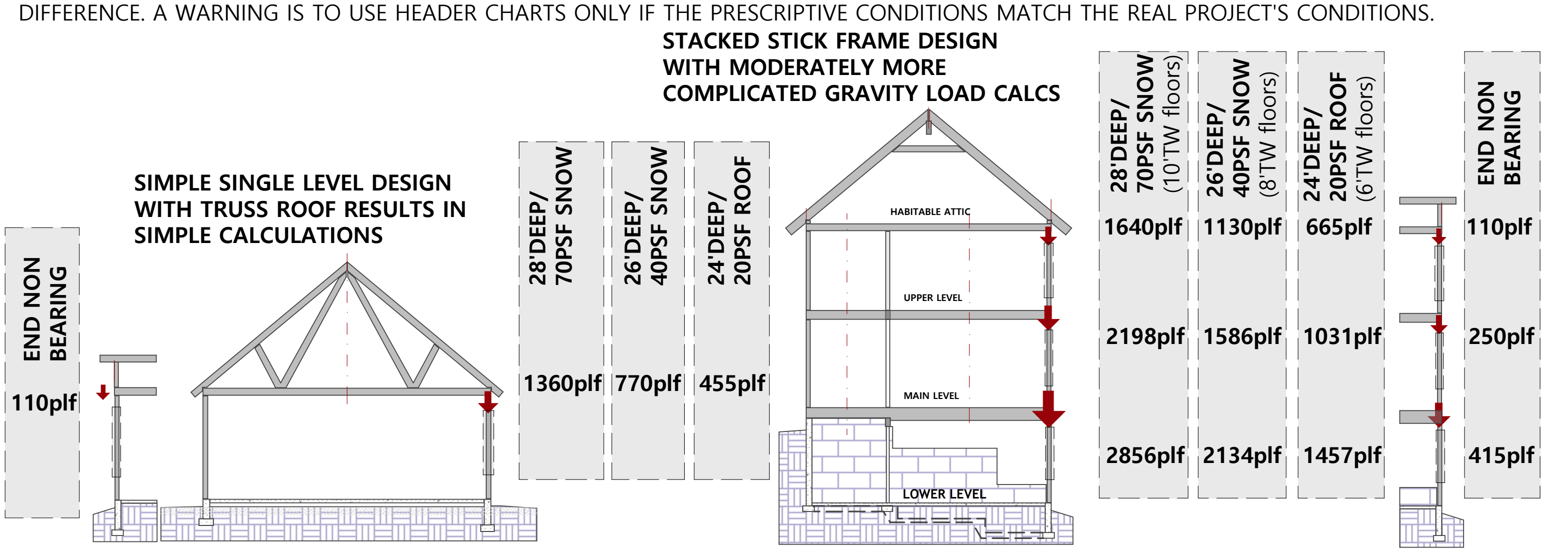
H1_6" NOMINAL HT
***3' SPAN**_COVERS VIRTUALLY ALL SINGLE DOORS AND WINDOWS
1_2-2X6 TO 3'=1200 PLF LOAD CAPACITY
1 JACK/1 KING PASS LOAD/BEARING/WIND
2_1-5.5 LVL TO 3'=1700 PLF LOAD CAPACITY
1 JACK/1 KING PASS LOAD/BEARING/WIND
3_2-5.5" LVL TO 3'=5100 PLF LOAD CAPACITY
1 JACK/1 KING PASS LOAD/BEARING/WIND

H2_10" NOMINAL HT
***6' SPAN**_COVERS VIRTUALLY ALL DOUBLE DOORS AND TWIN WINDOWS
1_2-2X10 TO 6'=750 PLF LOAD CAPACITY
1 JACK/2KINGS PASS LOAD/BEARING/WIND
2_1-9.25" LVL TO 6'=1200 PLF LOAD CAPACITY
1 JACK/2KINGS PASS LOAD/BEARING/WIND
3_2-9.25" LVL TO 6'=2400 PLF LOAD CAPACITY
1 JACK/1 KING PASS LOAD/BEARING/WIND UP TO A 2000 PLF LOAD. ABOVE 2000 REQUIRES 2 JACKS

H3_CUSTOM HT AS REQUIRED
REQUIRE CALCULATION REGARDLESS OF SNOW LOADING. THE LONGER SPANS ARE SIMPLY MORE SENSITIVE TO LOADING AND DEFLECTION. DEFLECTION SHOULD BE HELD TO .25" OR BASED ON THE ACTUAL ROUGH OPENING CLEARANCE. OBVIOUSLY DO NOT WANT HEADER TO HIT DOOR OR WINDOW UNIT HEAD.

ANOTHER EXERCISE IN GRAVITY LOADS

***ADDED UP**_SIMILARLY TO THE WALL LOAD SUMMARIES (c6.9) HEADER LOADS ARE CALCULATED FROM ROOF DOWN TO A UNIFORM LOAD. THAT LOAD IN POUNDS PER LINEAR FOOT IS GRAVITY LOADING ON THE WALL AND ON THE HEADER. HALF THAT HEADER LOAD GETS DISTRIBUTED DOWN EACH SIDE THROUGH THE JACK STUD(S).
***LOADING**_IS MAKING A FEW POINTS. BEARING WALLS PRODUCE LARGER LOADS. LOADS ARE ACCUMULATIVE FROM ROOF TO LOWEST LEVEL. NON BEARING WALLS ARE RELATIVELY LIGHT LOADS. THE 2 VARIABLES- SNOW LOADING AND TRIBUTARY WIDTH MAKE A SIGNIFICANT DIFFERENCE. A WARNING IS TO USE HEADER CHARTS ONLY IF THE PRESCRIPTIVE CONDITIONS MATCH THE REAL PROJECT'S CONDITIONS.



***HEADER SPANS**_LOADS AS CHARTED BELOW ARE VALID. REACTIONS-WHICH IS THE LOAD EACH JACK IS REQUIRED TO HANDLE ARE VALID. THE JACKS NOTED CAN HANDLE THE LOAD BUT.......

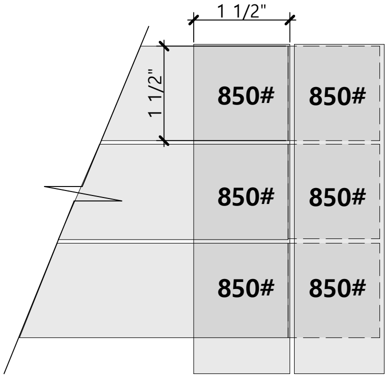
***425 PSI**_SOMEWHERE IN THE HEADER LOAD PATH THE LOAD IS RESTING ON THE BOTTOM OF THE HEADER, OR BOTTOM OF A HEADER PLATE (IF THERE IS ONE), OR WHERE THE JACKS SIT ON THE WALL PLATE. THAT LOAD IS SITTING PERPENDICULAR TO THE GRAIN. THE SPF IS LIMITED TO 425 PSI. THIS RATING FOR HEM-FIR IS 405 PSI, AND THE RATING FOR DOUGLAS FIR-LARCH IS 625 PSI. THIS IS ANOTHER LIMITING VARIABLE.

DIMENSIONAL LUMBER HEADER SPAN AND JACK CAPACITY CHART

CAPACITY BY 'UNIT' OF BEARING
*UNIT OF BEARING IS 1-2X HEADER SITTING ON 1-2X JACK=1.5"X1.5"
*1.5"X 1.5"=2.25 SI Q IN X 425 PSI CAPACITY=956# ROUNDED DOWN TO 850# TO ALLOW FOR A LITTLE LESS THAN FULL AREA BEARING.

JACK CAPACITY IN UNITS
*1 UNIT=850#
*2 UNITS=1700#
*3 UNITS=2550#
*4 UNITS=3400#
*6 UNITS=5100#

R=REACTION
*SPAN CAPCITY LOADING SHOWN FOR #2 SPF TO WITHIN 5% OF MAX
*R=LOAD CAPACITY (PLF) X SPAN LENGTH DIVIDED BY 2.
*MATCH REACTION LOADS TO BEARING CAPACITY TO DETERMINE MINIMUM JACK REQUIREMENT.



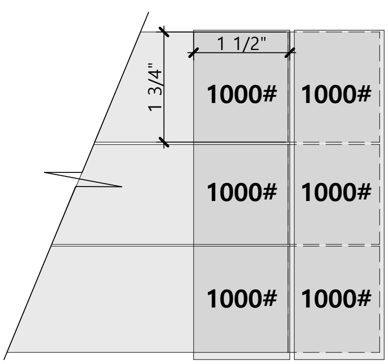
1-2x4	2-2x4	1-2x6	2-2x6	Member	3'span	R_	6'span	R_	9'span	R_	12'span	R_
1unit	2units	1unit	2units	**1-2x6**	600plf	900#	150plf	450#	65plf	293#		
2units	4units	2units	4units	**2-2x6**	1200plf	1800#	300plf	900#	130plf	585#		
		3units	6units	**3-2x6**	2000plf	3000#	525plf	1575#	225plf	1013#		
1unit	2units	1unit	2units	**1-2x8**	1000plf	1500#	250plf	750#	110plf	495#		
2units	4units	2units	4units	**2-2x8**	2000plf	3000#	500plf	1500#	225plf	1013#		
		3units	6units	**3-2x8**	3200plf	3300#	850plf	2550#	375plf	1688#	210plf	1260#
1unit	2units	1unit	2units	**1-2x10**	1500plf	2250#	375plf	1125#	160plf	720#		
2units	4units	2units	4units	**2-2x10**	3000plf	4500#	750plf	2250#	325plf	1463#	175plf	1050#
		3units	6units	**3-2x10**	4800plf	7200#	1200plf	3600#	550plf	2475#	310plf	1860#
1unit	2units	1unit	2units	**1-2x12**	2000plf	3000#	500plf	1500#	215plf	968#	115plf	690#
2units	4units	2units	4units	**2-2x12**	4000plf	6000#	1000plf	3000#	330plf	1485#	240plf	1440#
		3units	6units	**3-2x12**	6800plf	10200#	1700plf	5100#	750plf	3375#	425plf	2550#

LVL HEADER SPAN AND JACK CAPACITY CHART

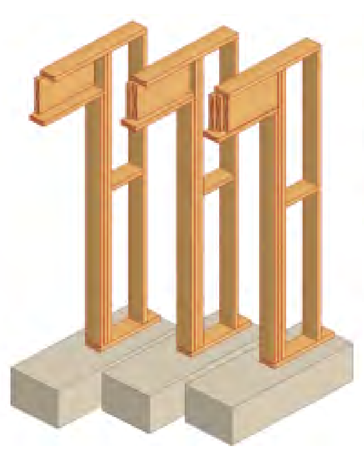
CAPACITY BY 'UNIT' OF BEARING
*UNIT OF BEARING IS 1-LVL HEADER SITTING ON 1-2X JACK= 1.75"X1.5"
*1.75"X 1.5"=2.625 SI Q IN X 425 PSI CAPACITY=1115# ROUNDED DOWN TO 1000# TO ALLOW FOR A LITTLE LESS THAN FULL AREA BEARING.

JACK CAPACITY IN UNITS
*1 UNIT=1000#
*2 UNITS=200#
*3 UNITS=300#
*4 UNITS=400#
*6 UNITS=6000#

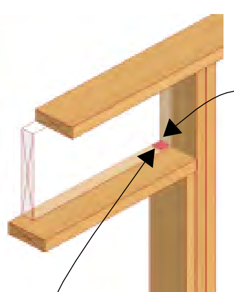
R=REACTION
*SPAN CAPCITY LOADING SHOWN FOR #2 SPF TO WITHIN 5% OF MAX
*R=LOAD CAPACITY (PLF) X SPAN LENGTH DIVIDED BY 2.
*MATCH REACTION LOADS TO BEARING CAPACITY TO DETERMINE MINIMUM JACK REQUIREMENT.



1-2x4	2-2x4	1-2x6	2-2x6	LVL Member	3'span	R_	6'span	R_	9'span	R_	12'span	R_
1unit	2units	1unit	2units	**1-5.5**	1700plf	2550#	400plf	1200#	135plf	608#		
2units	4units	2units	4units	**2-5.5**	3400plf	5100#	850plf	2550#	265plf	1193#		
		3units	6units	**3-5.5**	5100plf	7650#	1300plf	3900#	375plf	1688#		
				1-7.25	2600plf	3900#	750plf	2250#	310plf	1395#	125plf	750#
				2-7.25	5200plf	7800#	1500plf	4500#	620plf	2790#	250plf	1500#
				3-7.25	7800plf	11700#	2300plf	6900#	925plf	4163#	375plf	2250#
				1-9.25	4000plf	6000#	1200plf	3600#	525plf	2363#	250plf	1500#
				2-9.25	8000plf	12000#	2400plf	7200#	1075plf	4838#	500plf	3000#
				3-9.25	12000plf	18000#	3600plf	10800#	1600plf	7200#	750plf	4500#
				1-11.875	7000plf	10500#	1900plf	5700#	850plf	3825#	475plf	2850#
				2-11.875	14000plf	21000#	3800plf	11400#	1700plf	7650#	950plf	5700#
				3-11.875	21000plf	31500#	5700plf	17100#	2550plf	11475#	1425plf	8550#

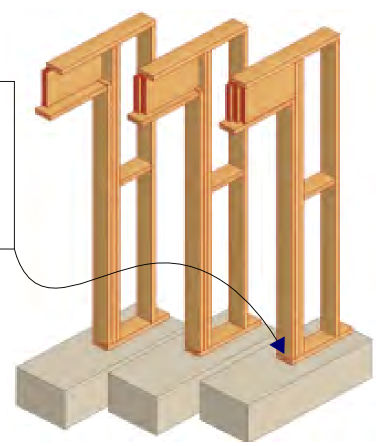


1, 2, 3 DIMENSIONAL LUMBER HEADERS

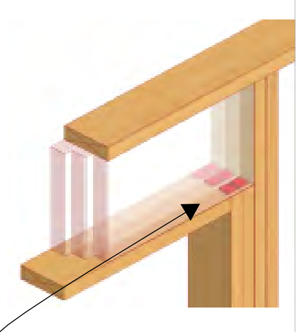


*THIS LOAD LIMIT IS A FUNCTION OF THE COMPRESSION PERPENDICULAR TO THE GRAIN RATING FOR THE WOOD SPECIES.

*1 BEARING UNIT or 850#

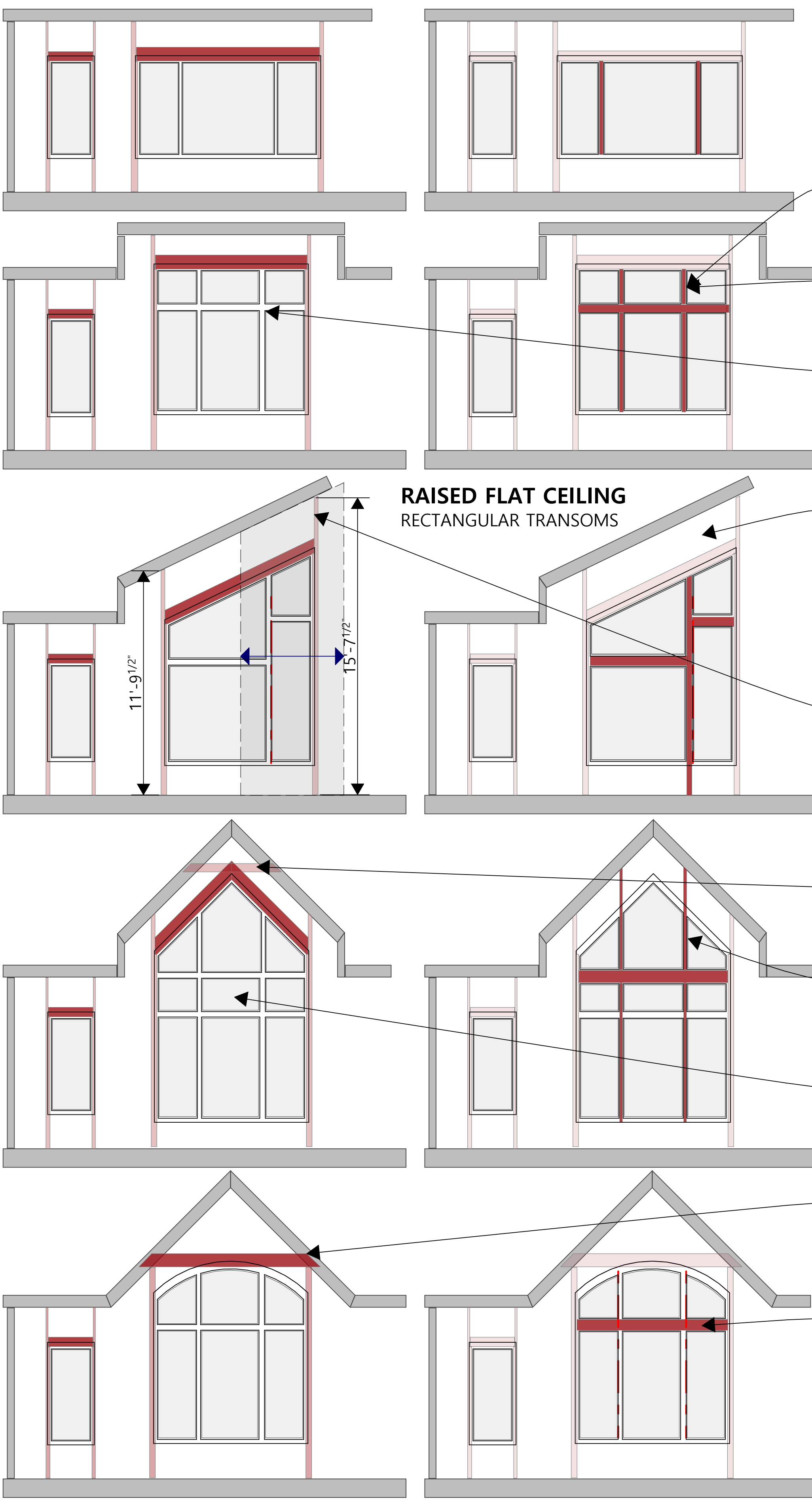


1, 2, 3 LVL HEADERS



*1 BEARING UNITS @1000# OR 6000#

FACTORY MULLED UNITS | FIELD MULLED UNITS



FACTORY AND FIELD MULLING

***SEE d11.10_**NOTES THE GENERAL CONSIDERATIONS FOR MULLING. THIS PAGE IS POINTING OUT SOME DETAILS THAT WANT CONSIDERATION. THE HEADERS- REGARDING GRAVITY LOADING- AND KING/JACKS REGARDING WIND LOADING ARE INCLUDED HERE

***OPTIONS_**THESE SHEMATICS DO **NOT** SHOW ALL OPTIONS FOR A MULLED PACKAGE

*TYPICAL OPTIONS_ this configuration is to mull the transons 3 across and the casements 3 across. Or mull a transom and casement creating 3 vertical units.

*AS DRAWN_ a framing decision needs to be made whether the mid header runs thru left to right or the vertical studs run thru top to bottom. Load distribution and header size is effected.

*SIZE_this general size mulled unit can be handled by a framing crew. Units showing below may become a challenge. Sometimes a crane is used if outide perimter perimeter

*END WALLS_the window assemmblies here and the 2 below are by their nature non bearing. Therefore the structural concern will likely center around the wind condition and not the gravity load condition. Not yet mentioned is that long headers are also subject to wind wobble. They are facing the wind with their smaller depth dimension-weaker geometry.

*WIND_this tall king/jack is one that wants structural verification. If that wobbles in the wind the window set and the trims will slowly and surely get 'loose'

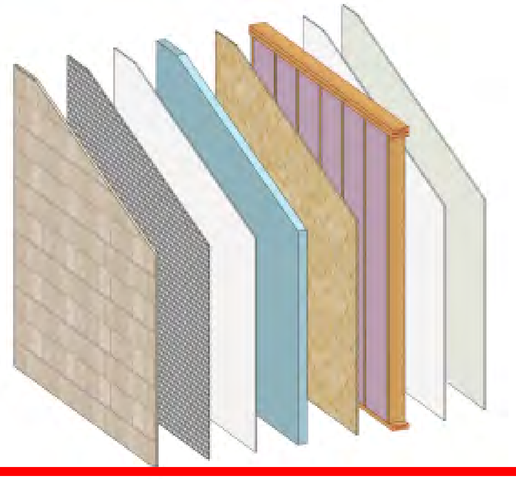
*BRACING_this header over he trap would benefit from a cross member tieing header to rafters each side. '

*BRACING_running sigle piece kings up to the rafters is another way to firm up the higher portion of this wall. The rafters are part of the rigid roof plane- made so with it's continuous sheathing.

*WEIGHT_this unit may be too much. Its the glass- at about 6-7 pounds per square foot. And handling tends to a lot of torque pressure on the continuous connections that they were not really designed for.

*CROSS MEMBER WANTED_a header is likely wanted this situation to generally stabilize the end wall. The end rafters sitting directly on top od the end wall can manage the gravity loading-but they don't do anything for the wall wobble.

*ARCH TRANSOM_this header position is common when an arch transon extends up into a gable. It also often benefits the 'look' of this window assembly.

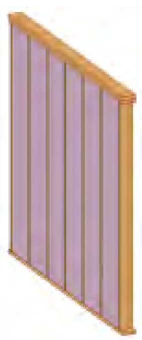


BASIC FUNCTIONS IN THE FRAME WALL ASSEMBLY

***SIMPLIFIED_**EXTERIOR SIDING KEEPS THE WEATHER OUT, EXTERIOR SHEATHING KEEPS THE HOUSE SQUARE AND PLUMB AND LATERALLY STRONG, THE FRAME WALLS HOLD IT UP AND HOUSE THE INSULATION. THE INTERIOR FINISH MAKE THE INTERIOR SPACES HAVE THE LOOK AND FEEL WE WANT. THESE PRIMARY FUNCTIONS HAVE NOT CHANGED MUCH. ONE DOES NOT HAVE TO COMPLICATE THIS, AND WALL ASSEMBLIES CAN BE KEPT SIMPLE.
***SO WHY THE COMPLICATIONS?_**EFFORTS TO TIGHTEN UP WALL ASSEMBLIES AND MAKE THEM MORE ENERGY AND WEATHER EFFICIENT, AND TO HAVE THEM REMAIN HEALTHY AND UNCOMPROMISED FOR A LONGER LIFE SPAN, HAVE OPENED UP OPTIONS, ADDITIONAL LAYERS, AND SOME AND COMPLICATIONS. THESE NEWER WALL ASSEMBLY OPTIONS ALL HAVE GOOD INTENTIONS, BUT THEIR APPROPRIATE SELECTION AND INSTALLATION IS ALWAYS CONDITIONAL ON SOMETIMES MANY FACTORS SO ARE NOT BY AND LARGE 'NO BRAINERS'.
***WEIGHING VALUE_**EACH PROBLEM SOLVING LAYER HAS A HYGRO-THERMAL CONSEQUENCE, AND A HOUSE LONGEVITY CONSEQUENCE, AND A LABOR AND MATERIAL COST CONSEQUENCE. ALTHOUGH WE TEND TO DISREGARD THIS IN GENERAL, THESE LAYERS **MUST** BE PROPERLY INSTALLED -WHICH MEANS CAREFULLY INSTALLED. THERE IS NO PERFECT AND UNIVERSAL WALL ASSEMBLY.

INSIDE

***FINISH_**THE UBIQUITOUS INTERIOR FINISH IS SHEETROCK, aka GWB (**G**YPSUM **W**ALL**B**OARD). LOTS OF OTHER CHOICES. USUALLY A COSMETIC CHOICE, BUT SOMETIMES NEEDED TO ASSIST IN LATERAL BRACING, SOMETIMES WANTED AS THERMAL MASS.
***INTERIOR VAPOR RETADER_**THIS SIMPLE ITEM IS A COMPLICATION FROM THE STANDPOINT OF KNOWING WHEN TO USE IT AND WHEN NOT TO USE IT. CODE EXPECTATIONS EXPLAINED (c6.21).

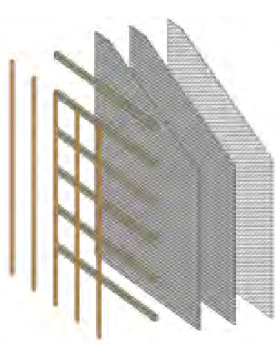


CAVITY INSULATION

***FILL IT UP_**REALLY COLD CLIMATES MAY EMPLOY INSULATION STRATEGIES THAT AVOID CAVITY INSULATION BUT FILLING UP THE CAVITIES WITH AN INSULATION OF CHOICE IS ABSOLUTELY MOST COMMON.
***THE CHALLENGE_**MAYBE THE PRIME FRUSTRATION WITH CAVITY INSULATION IS THE INCREDIBLE PERIMETER IT MUST BE TIGHT WITH. THINK OF 20 LIN FT EVERY STUD SPACE. THIS TIGHTNESS IS MORE IMPORTANT THAN 'R'.

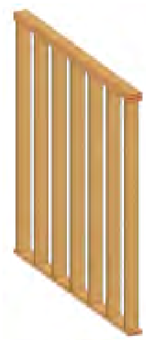
CONTINUOUS INSULATION

***EFFECTIVE STUFF_**SOMETIMES CALLED EXSULATION THIS IS AN UNBROKEN EXTERIOR SHEETGOOD INSULATION COVERING THAT IS INSTALLED TIGHT. EFFECTIVE STUFF, GREATLY BECAUSE IT IS CONTINUOUS. AND DOES NOT HAVE TO FIGHT THE EDGE BATTLE CAVITY INSULATION DOES. PICK YOUR MATERIAL, PRICE, R-VALUE. THE 4 PRIMARY PRODUCTS GO ON THE SAME WAY.
***FASTENERS_**THICKER INSULATION WANT A FASTENER STATEGY.



OUTSIDE AIR SPACE

***AIR SPACE_**WATER AND MOISTURE GET BEHIND ANY SIDING. WIND DRIVEN WATER, LEAKS, MIGRATION. IT IS GOOD FOR IT TO HAVE A MEANS TO DRIP OUT, DRY OUT. THIS IS ANOTHER CONSTRUCTION, MATERIAL, CLIMATE SPECIFIC CONDITION. START WITH THE SIDING SELECTION AND ASK WHAT IT NEEDS TO STAY DRY ON THE BACKSIDE.



THE WALL

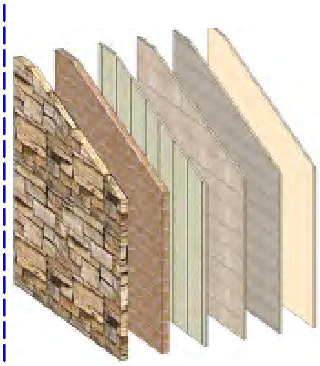
***STRUCTURE_**SEE EVERYTHING THAT PRECEEDS IN THIS CHAPTER.
***NAIL BASE_**PRETTY IMPORTANT-OUTSIDE AND IN. IT IS ONE OF THE THINGS THAT MAKES THE FRAME WALL SO FLEXIBLE AND USEFUL.
***SYSTEMS_**ELECTRICAL AND SOME PLUMBING ARE FREQUENT INHABITANTS OF THE WALL. THERE ARE RULES ABOUT WHAT CAN AND CANNOT BE CUT/REMOVED. CODE CHAPTER 6.

BRACING

***CRITERION_**KEEPING THE STICKS STRAIGHT PERMANENTLY-AND IN THE WIND-IS THE JOB OF ANY SELECTED BRACING SYSTEM.
***MEANS_**STRUCTURAL SHEATHING, DIAGONAL BRACING, ENGINEERED SHEAR WALLS/TIE DOWNS ARE OPTIONS. (c8) ADDRSSES THE WHOLE BUILDING SHELL AND ITS REQUIREMENT TO RESIST LATERAL PRESSURE.

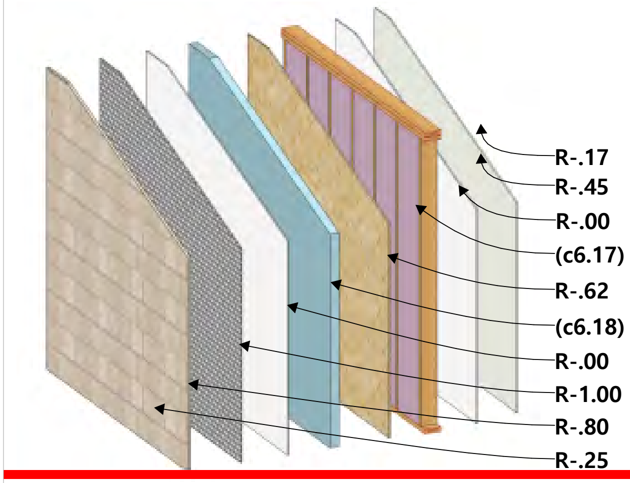
THE WEATHER BARRIER

***EXTERNAL WRB_**THE WEATHER RESISTANT BARRIER PROTECTS EVERYTHING INSIDE OF IT FROM WATER AND AIR PENETRATION. CODE REFERENCES THIS AS THE WATER RESISTANT BARRIER, BUT NO MATTER THE JOB IS THE SAME. NOTE THAT AIR 'SEALING' IS AN ADDITIONAL STEP IN ACHIEVING THE TIGHT HOUSE [c8].
***OPTIONS_**THERE ARE DIFFERING STRATEGIES AND MATERIAL CHOICES FOR THIS LAYER. THIS LAYER HAS HIGH EXPECTATIONS AND REQUIRES CAREFUL INSTALLATION.



OUTSIDE SKINS

***PROTECTION_**THIS PRIMARY LINE OF DEFENSE TAKES A GOOD BEATING. SUN RAIN, WIND, HUGE TEMPERATURE DIFFERENTIALS. THINK TWICE ABOUT UP FRONT INVESTMENT AND LONG TERM MAINTENANCE.
***AESTHETICS_**ARE NOT BEING DISCOUNTED. AS WE ALL KNOW SIDING IS A PRIME PLAYER IN ACHIEVING A SATISFACTORY HOUSE LOOK.



TYPICAL FRAME WALL ASSEMBLY AND R VALUE

***CODE OR BEST PRACTICE**_CODE REQUIREMENTS FOR INSULATION MINIMUMS CAN BE CALCULATED A COUPLE OF WAYS . SEE (c9.4, c9.5, c9.6). ONE ALSO HAS THE CHOICE OF SELECTING INSULATION (AND A WALL ASSEMBLY) TO MEET CODE, OR TO MEET A USER DEFINED WHOLE HOUSE ENERGY AND COMFORT CRITERIA. THERE IS A BIGGER PICTURE BUT THE CODE IS NOT A WRONG PLACE TO START THE CONVERSATION AND

***COMPONENT R**_R VALUES IS THE EASIER AND MORE COMMON LANGUAGE USED FOR DISCUSSING AND MAKING PRODUCT AND ASSEMBLY DECISIONS. MORE R-MORE CONSERVED ENERGY. THE CODE HAS SET MIN R-VALUES FOR INSULATION (ONLY) FOR THE WALL ASSEMBLY. THE INSULATION ITSELF CARRIES THE BALL. IT IS WORTH KNOWING THAT MOST OTHER COMPONENTS IN THE ASSEMBLY HAVE SOME R VALUE ASSOCIATED WITH THEM.

***ASSEMBLY 'U' AND RES CHECK**_ARE 2 OTHER SOMEWHAT MORE COMPLICATED METHODS OF ESTABLISHING CODE ENERGY COMPLIANCE. THESE ARE BEING KEPT OUT OF THE WALL DISCUSSION BECAUSE THEY ARE WHOLE HOUSE BASED.

TABLE N1102.1.2 (R402.1.2) INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE[i]	FLOOR R-VALUE	BASEMENT[c] WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

CODE R

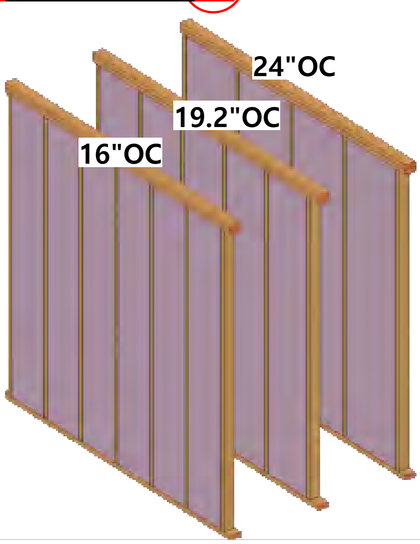
***20+13**_ARE THE 'GROSS' VALUES OF THE SELECTED INSULATION FOR INSTALLATION BETWEEN THE STUDS. (c6.18) SHOWS A SUMMARY LIST OF CAVITY INSULATION TYPES AND THEIR R VALUES. BECAUSE OF THE RANGE OF VALUES PER INCH THE **20** REQUIREMENT IS SUITABLE FOR 2X6 CONSTRUCTION, AND THE **13** IS SUITABLE FOR 2X4 CONSTRUCTION. THE SECOND NUMBERS +**5** AND +**10** NUMBERS REFER TO CONTINUOUS EXTERIOR INSULATIONS WHERE REQUIRED. FOR EXAMPLE IN ZONES 3,4,5 R-20 CAVITY INSULATION IN (NECESSARILY) A 2X6 WALL PASSES CODE-OR R-13 CAVITY INSULATION IN A 2X4 WALL **PLUS** AN R-5 RIGID INSULATION OUTSIDE THE FRAMING WILL PASS CODE.

FRAME CAVITY WALL INSULATION INEFFICIENCY

*THESE FRAME WALL ADJUSTMENT FACTORS ACCOUNT FOR THE AMOUNT OF WOOD IN THE WALL. THE WOOD IS HAS A LESSER R-VALUE THAN INSULATIONS SO NATURALLY DRAGS THE NET WALL VALUE DOWN SOME. THESE NETS ARE A FUNCTION OF STUD CENTERS, AND THE ADVANCED FRAMING NUMBERS HAS ADDITIONAL FACTORS INCLUDING HAVING ONLY 1 TOP PLATE. THESE REDUCTIONS NEED TO BE PLACED IN THE BIGGER PICTURE BEFORE MAKING FIXED JUDGEMENTS ON WHAT THE SMART THING TO DO IS.

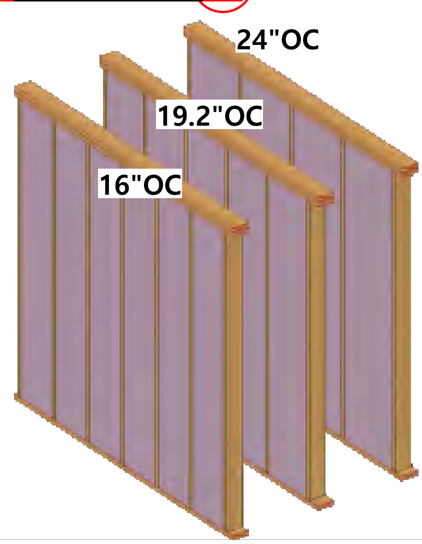
2x4 WALLS 3.5" X 3.7 PER INCH=13

STANDARD FRAMING
*16"OC_ 23% FACTOR
NET R=10
*19.2"OC_21.5% FACTOR
NET R=10.2
*24"OC_20% FACTOR
NET R=10.4
ADVANCED FRAMING
*16"OC_19% FACTOR
NET R=10.5
*19.2"OC_17.5% FACTOR
NET R=10.7
*24"OC_16% FACTOR
NET R=10.9



2x6 WALLS 3.5" X 3.7 PER INCH=20

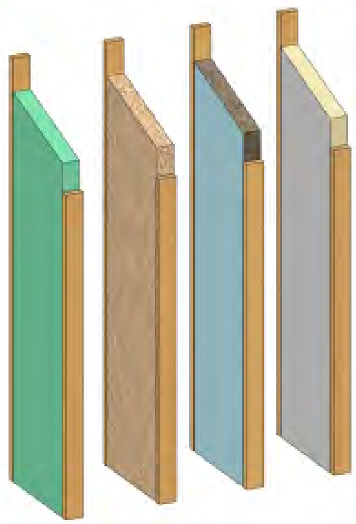
STANDARD FRAMING
*16"OC_ 23% FACTOR
NET R=15.4
*19.2"OC_21.5% FACTOR
NET R=15.7
*24"OC_20% FACTOR
NET R=16
ADVANCED FRAMING
*16"OC_19% FACTOR
NET R=16.2
*19.2"OC_17.5% FACTOR
NET R=16.5
*24"OC_16% FACTOR
NET R=16.8



WALL EXTERIOR INSULATION

THINKING AHEAD

***THE EXSULATION_**THE REQUIREMENT FOR- AND THE BENEFITS OF-THE EXTERIOR INSULATION JUST IS. THERE ARE SOME CONCERNS AND CHALLENGES WHICH MOSTLY STEM FROM THE THICKNESS OF THE NON STRUCTURAL RIGID INSULATION. IT IS A 'DEVIL IN THE DETAIL' SITUATION WORTH CONSIDERING, IN FACT MAKING VERY SPECIFIC PLANS FOR.
***FASTENING AND DEPTH OF INSULATION_**WHEN RIGID GETS THICK FASTENING THRU IT GETS HARDER. NAILS WON'T GET ENOUGH PENETRATION/PURCHASE. SCREWS MAY BECOME NECESSARY. EVEN WITH SCREWS SOME FASTENING SITUATIONS ARE CHALLENGED. CONSIDER RIGID THICKNESSES COULD BE ANYWHERE FROM 1/2" TO 4". ANY THICKNESS OVER 1" WANTS FASTENING CONSIDERATION.
***LOCATING THE STRUCTURAL (BRACING) SKIN_**OSB CAN BE PLACED ON THE STUDS WITH RIGID INSULATION OUTBOARD. OR THE RIGID CAN BE PLACED ON THE STUDS AND THE OSB OUTBOARD. IF THE OUTBOARD OSB IS TOO FAR OUT TO SATISFY LATERAL BRACING NEEDS BECAUSE OF FASTENER LENGTH THEN ANOTHER BRACING SOLUTION AT THE STUD PLANE WILL NEED TO BE CONSIDERED.
***THIS CONSIDERATION_**OF HOW THICK AND WHERE RIGID IS LOCATED MAY DRIVE A NUMBER OF OTHER DECISIONS.



CAVITY INSULATION PRODUCTS

*THE APPEAL OF CAVITY INSULATION IS THAT THE CAVITY IS THERE- WAITING TO BE USED.
*ALL CAVITY PRODUCTS HAVE THE CHALLENGE OF STAYING ON CONTACT WITH THE PERIMETER STUD BOUNDARY.ANOTHER CHALLENGE IS DEALING WITH BLOCKING, ELECTRICAL WIRING AND BOXES, AND POSSIBLY SOME PLUMBING. GAPS AND VOIDS COMPROMISE THE R-VALUE.
*THE 3 INSTALLATION TYPES ARE BATTS/BLANKETS, BLOWN IN 'LOOSE' INSULATION (THAT HAS SOME BINDING CAPACITY IN THE APPLICATION PROCESS), AND SPRAY FOAM. THESE 3 TYPES HAVE THEIR OWN SETS OF PROS AND CONS. THE PECKING ORDER OF COSTS WILL BE BATTS, LOOSE, SPRAY FOAM. THE PECKING ORDER OF IN PLACE EFFECTIVE R PRETTY MUCH FOLLOWS THAT COST SEQUENCING. BUT AS ANY RESEARCH WILL VERIFY, ANY OR ALL OF THESE CAN BE PROPERLY AND CAREFULLY INSTALLED AND EFFECTIVE, OR NOT.

CAVITY WALL UNIT INSULATION VALUES

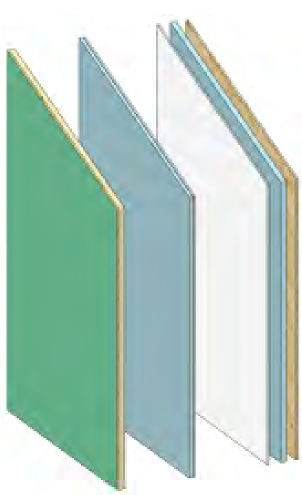
FIBERGLASS BATTS_**3.1-3.4**
FIBERGLASS BLOWN_**3.7-4.3**
MINERAL WOOL BATTS_**3.1-3.4**
MINERAL WOOL BLOWN_**3.1-4.0**
CELLULOSE BLOWN_**3.8-3.9**
OPEN CELL SPRAY FOAM_**3.5-3.6**
CLOSED CELL SPRAY FOAM_**6.0-6.5**

THE RIGID EXTERIOR INSULATION PRODUCTS

*THESE ARE ALL SHEETGOODS, OR RIGID BOARD PRODUCTS. THE MORE COMMON SIZE IS 4'X8', BUT A VARIETY OF SIZES MAY BE AVAILABLE. THICKNESSES VARY, AND ARE SELECTED ON AN R VALUE DESIRED AS ALL PRODUCTS ARE VALUED BY **R-PER INCH**.
*THESE PRODUCTS ARE LIGHT IN WEIGHT, EASY TO MOVE, WORK, CUT. AND FAIRLY EASY TO DAMAGE.
*THESE PRODUCTS ADD THICKNESS TO A FRAME WALL ASSEMBLY, AND THERFORE ALTER SOME 'STANDARD' CONSTRUCTION PRACTICES. DOOR AND WINDOW JAMB DEPTHS ARE EFFECTED AND NAILING/FASTENING IN GENERAL IS EFFECTED.
*THIS 'EXSULATION' IS UNDENIABLY EFFECTIVE IMPORTANTLY BECAUSE IT CREATES A THERMAL BARRIER FOR ALL THE WOOD THAT IS OTHERWISE TRANSFERING HEAT FASTER THAN WANTED.

EXSULATION UNIT INSULATION VALUES

POLYISO_POLYISOCYANURATE_**6.0-6.5**
XPS_EXTRUDED POLYSTYRENE_**5.0**
ROCKWOOL BOARD_**4.0**
EPS_EXPANDED POLYSTYRENE_**3.5**



COMPOSITE PRODUCTS aka STRUCTURAL INSULATED SHEATHING

*COMBINING STRUCTURAL SHEATHING AND RIGID INSULATION INTO 1 PRODUCT EXISTS, AND IS LIKELY TO BECOME MORE USED AND AFFORDABLE AS MARKET DEMAND EXPANDS.
*THE DRAW IS SIMPLICITY AS 1 PROPERLY EXECUTED CONSTRUCTION STEP CAN ADDRESS 3 ASSEMBLY REQUIREMENTS. SPECIFICALLY HUBERS ZIP PRODUCT HAS AN OSB STRUCTURAL BASE WITH TREATED OUTSIDE (CODE ACCEPTABLE AS THE WRB) SURFACE, AND A LAMINATED POLYISO INSULATION LAYER (4 THICKNESSES AVAILABLE) ON THE INSIDE FACE. SO WRB, STRUCTURAL SHEATHING, EXTERIOR INSULATION IS ONE PRODECT, ONE INSTALL. PRICEY PRODUCT AT THE MOMENT. MORE MANUFACTURERS ARE SEEING A MARKET HERE.
*THE STRUCTURAL PANEL NEEDS TO BE A NAIL BASE, AND NEEDS TO SATISFY LATERAL BRACING DEMANDS. THE FUSED INSULATION CAN BE ANY OF THE 3 GENERIC TYPES. POLYISO THAT HUBER USES IS THE MOST EFFICIENT R PER INCH OR THICKNESS AND THE MORE EXPENSIVE.

EXSULATION COMBINATION PRODUCTS

ZIP R SHEATHING_R-3/R-6/R-9/R-12.2
GOOGLE_STRUCTURALLY INSULATED SHEATHING

FRAME WALLS c6.19
CODE REQUIRED INSULATION

ZONE 1
MIAMI FL
JAN_76°/60°–83%/59%
JUL_96°/74°_86%/66%
HONOLULU H
JAN_80°/66°–86%/53%
JULY_88°/74°_92%/64%

2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
2x4 ZONE 1

2X6 @16/19.2/24
R-17.5 OR UP
5.5"x3.1per in=20
5.5"x4.1per in=23
2x6 ZONE 1

ZONE 2
AUSTIN TX
JAN_62°/42°–78%/52%
JUL_96°/74°_88%/44%
ORLANDO FL
JAN_71°/49°–86%/53%
JULY_92°/74°_92%/64%

2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
2x4 ZONE 2

2X6 @16/19.2/24
R-20 OR UP
5.5"x3.1per in=20
5.5"x4.1per in=23
2x6 ZONE 2

ZONE 3
ATLANTA GA
JAN_53°/32°–76%/54%
JUL_89°/69°_89%/58%
BAKERSFIELD CA
JAN_64°/43°–83%/63%
JULY_97°/68°_48%/22%

2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
R-5
1"xps=5
2x4 ZONE 3

2X6 @16/19.2/24
R-20 min
5.5"x3.7per in=20
2x6 ZONE 3

ZONE 4a,4b
RICHMOND VA
JAN_48°/59°–78%/53%
JUL_96°/68°_91%/57%
WITHITA KA
JAN_44°/22°–79%/63%
JULY_92°/69°_79%/49%

2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
R-5
1"xps=5
2x4 ZONE 4a,b

2X6 @16/19.2/24
R-20 min
5.5"x3.7per in=20
2x6 ZONE 4a,b

WALLS-IRC 2018
IRC BASELINE R VALUE REQUIREMNTS BY COMPONENT. EXCEPTIONS BELOW RESTRICTED TO COLDER CLIMATE ZONES AS NOTED

ZONE 1____[R-13]
ZONE 2____[R-13]
ZONE 3____[R-20] or [R-13] + {5}
ZONE 4a+b_[R-20] or [R-13] + {5}
ZONE 4c___[R-20] or [R-13] + {5}
ZONE 5____[R-20] or [R-13] + {5}
ZONE 6____[R-20] + {5} or [R-13] + {10}
ZONE 7____[R-20] + {5} or [R-13] + {10}
[X] CAVITY INSULATION
{X} CONTINUOUS EXTERIOR INSULATION

WALLS-IRC 2018
EXCEPTIONS PER R702.3 PERMITTING CLASS III VAPOR RETARDER

ZONE 4c___[R-20] + {3.75} or [R-13] + {2.5}
ZONE 5____[R-20] + {7.5}or [R-13] + {5}
ZONE 6____[R-20] + {11.25} or [R-13] + {7.5}
ZONE 7____[R-20] + {15} or [R-13] + {10}
[X] CAVITY INSULATION
{X} CONTINUOUS EXTERIOR INSULATION

DRY TO THE OUSIDE PER N1102.1.2

DRY TO THE INSIDE PER R702.7.1

ZONE 4c MARINE
SEATTLE WA
JAN_46°/36°–81%/74%
JUL_78°/56°_81%/49%
EUGENE OR
JAN_49°/36°–92%/80%
JULY_84°/55°_88%/38%

CLASS I,II
2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
R-5
1"xps=5
2x4 ZONE 4c

CLASS I,II
2X6 @16/19.2/24
R-20 min
5.5"x3.7per in=20
2x6 ZONE 4c

CLASS III
2X4 @16/19.2/24
R-13*
3.5"x3.7per in=13
R-2.5*
.5""xps=2.5
2x4 ZONE 4c

CLASS III
2X6 @16/19.2/24
R-20*
5.5"x3.7per in=20
R-3.75*
.75"xps=3.75
2x6 ZONE 4c

ZONE 5
PITTSBURGH PA
JAN_38°/21°–74%/63%
JUL_84°/62°_84%/53%
DENVER CO
JAN_46°/19°–63%/49%
JULY_92°/59°_68%/34%

CLASS I,II
2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
R-5
1"xps=5
2x4 ZONE 5

CLASS I,II
2X6 @16/19.2/24
R-20 min
5.5"x3.7per in=20
2x6 ZONE 5

CLASS III
2X4 @16/19.2/24
R-13*
3.5"x3.7per in=13
R-5*
1"xps=5
2x4 ZONE 5

CLASS III
2X6 @16/19.2/24
R-20*
5.5"x3.7per in=20
R-7.5*
1.5"xps=7.5
2x6 ZONE 5

ZONE 6
BANGOR ME
JAN_29°/9°–74%/66%
JUL_80°/58°_83%/58%
HELENA MT
JAN_36°/17°–71%/63%
JULY_85°/53°_67%/30%

CLASS I,II
2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
R-10
2"xps=10
2x4 ZONE 6

CLASS I,II
2X6 @16/19.2/24
R-20 min
5.5"x3.7per in=20
R-5
1"xps=5
2x6 ZONE 6

CLASS III
2X4 @16/19.2/24
R-13*
3.5"x3.7per in=13
R-7.5*
1.5"xps=7.5
2x4 ZONE 6

CLASS III
2X6 @16/19.2/24
R-20*
5.5"x3.7per in=20
R-11.25*
2.25"xps=11.25
2x6 ZONE 6

ZONE 7
DILUTH MN
JAN_23°/4°–77%/70%
JUL_81°/59°_85%/59%
FARGO ND
JAN_20°/2°–75%/72%
JULY_83°/60°_85%/55%

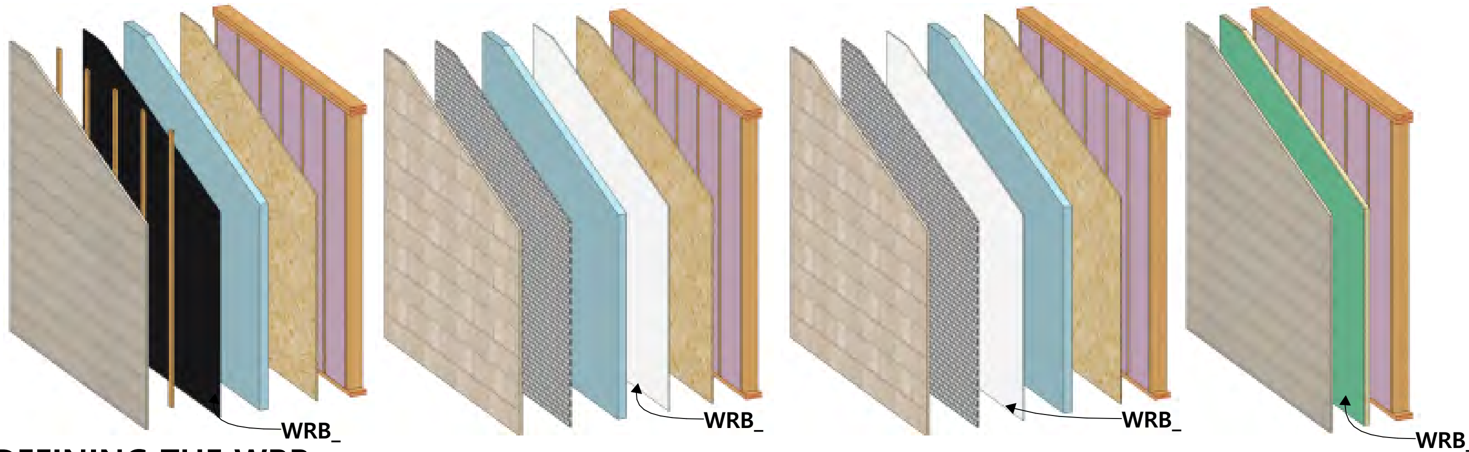
CLASS I,II
2X4 @16/19.2/24
R-13
3.5"x3.7per in=13
R-10
2"xps=10
2x4 ZONE 7

CLASS I,II
2X6 @16/19.2/24
R-20 min
5.5"x3.7per in=20
R-5
1"xps=5
2x6 ZONE 7

CLASS III
2X4 @16/19.2/24
R-13*
3.5"x3.7per in=13
R-10*
2"xps=10
2x4 ZONE 7

CLASS III
2X6 @16/19.2/24
R-20*
5.5"x3.7per in=20
R-15*
3"xps=15
2x6 ZONE 7

KEEP THE PRECIPITATION OUT

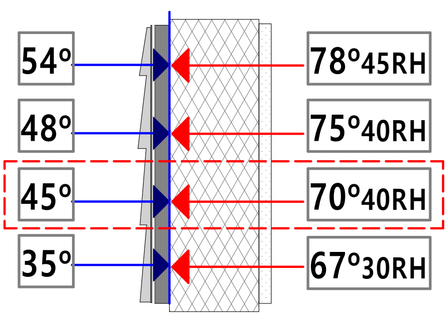


DEFINING THE WRB

***SAMPLE ILLUSTRATION_**THE JOB IS KEEPING WATER AND AIR OUT. THIS IS THE CAREFULLY INSTALLED, TAPED, SEALED, BUTTONED UP LAYER. WHAT COMPLICATES THIS TASK IS THERE ARE MANY CHOICES OF MATERIAL TO MEET THIS REQUIREMENT/SOLVE THIS PROBLEM.
***CODE_**REQUIREMENTS ARE FOR THIS BARRIER TO BE BEHIND ANY SIDING AND CAPABLE OF DRAINING ANY ACCUMULATED WATER. THIS RECOGNIZES THAT VIRTUALLY ALL EXTERIOR SIDINGS WILL PERMIT WATER PENETRATION BY LEAK/GAP/OR ABSORPTION. NOTE THAT WIND IS A PRIME PLAYER AND PUSHES WATER UP/OVER/THRU. WATER GETS BEHIND SIDING. DON'T LET IT PENETRATE FURTHER.
***DIFFERENCES_**FROM 'TAR PAPER' TO WOVEN FABRIC, TO TREATED OSB, TO FULL BLOWN 'RUBBER' MEMBRANES THESE MATERIAL CHOICES VARY. AND THEIR PERMEANCE VARIES (c6.21) WHICH MUST BE CONSIDERED. IT WANTS TO BE POSITIONED OUTSIDE OF ANY MATERIAL THAT CAN BE WATER COMPROMISED. THE INSTALLTION PROCEDURES CAN BE VASTLY DIFFERENT
***DEW POINT_**THE DEW POINT NEEDS SOME THOUGHT BECAUSE IT IS THE INVISBLE DEVIL THAT CAN PUT WATER IN THE WALL WITHOUT OUR BEING AWARE. WALL ASSEMBLY DESIGN CAN BE DETERMINED BY THIS DEW POINT CONCERN- AND CONSEQUENTLY THE BETTER WRB CHOICE.

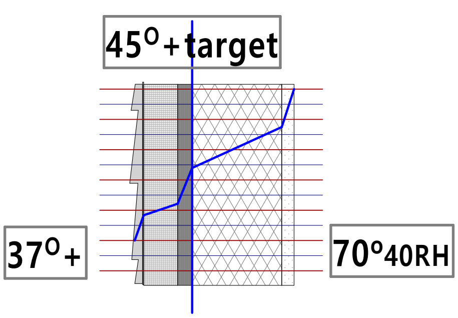
EXTERIOR INSULATION AND MANAGING THE DEW POINT

*BUILDING SCIENCE HAS RECOGNIZED THAT THE INSULATIION STRATEGY PERMITTED BY R702.7 CONSIDERS AND THEORETICALLY CONTROLS THE DEW POINT. THESE ASSEMBLIES MUST BE ALLOWED TO DRY TO THE INSIDE. THE BELOW TRIES TO EXPLAIN HOW THIS HAS BEEN ARRIVED AT AND WHY. THIS IS A COLDER CLIMATE ISSUE BECAUSE THE ACCEPTED DEW POINT TEMPERATURE OF CONCERN OF (45°+/-). WARMER CLIMATES MAY NOT HAVE WINTER TEMPERATURE AVERAGES THAT HIGH AND ARE THEREFORE REMAIN INHERENTLY OUT OF HARMS (DEW POINT) WAY.



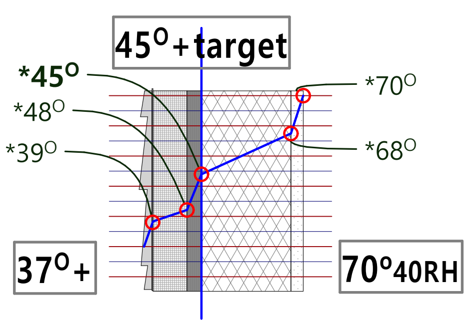
ACKNOWLEDGING THE DEW POINT

***THE DEW POINT_**(d2.6) IS WHEN WARM MOIST AIR HITS A CERTAIN COLDER TEMPERATURE (SURFACE) IT WLL 'CONDENSE. IN THE CONTEXT OF WALL ASSEMBLIES THIS CAN HAPPEN ON THE INSIDE FACE OF THE EXTERIOR SHEATHING. NOT WANTED.
***CHARTING THE NUMBERS_**THE PSYCHROMETRIC CHART INFORMS US OF THE DEW POINT TEMPERATURES BASED ON THE INTERIOR TEMPERATURES AND HUMIDITIES. ONE WANTS TO SET THIS BASED ON THE DESIRED INTERIOR WINTER TEMPERATURE AND HUMIDITY.
***SETTING A STANDARD_**THE INDUSTRY STANDARD IN THIS INSTANCE IS 70°/40%RH. THE IDEA IS THAT THIS INTERIOR CONDITION IS MORE OR LESS MAINTAINED. THEN THE MIN TEMPERATURE DESIRED FOR THE INSIDE SURFACE OF THE EXTRIOR WALL SHEATHING IS 45°, OR HIGHER. USING THESE NUMBERS THE AMOUNT OF INSULATION IS CALCULATED.



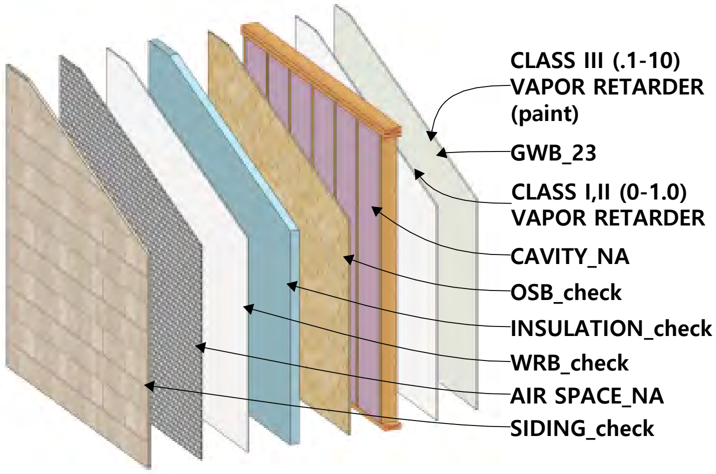
SET THE CONDITIONS

***SET THAT INSIDE (WINTER) STANDARD_** 70°/40% RH
***KNOW THE OUTSIDE WINTER CONDITION_**THE AVERAGE OF THE TEMPERATURES IN DECEMBER, JANUARY, FEBRUARY, HAS BECOME AN ACCEPTED STANDARD. THIS **33°** REPRESENTS THAT AVERAGE TEMPERATURE IN HELENA MONTANA-ZONE 6.
***THE GOAL_**IS TO PLACE ENOUGH EXTERIOR INSULATION TO INSURE THAT 45° TARGET IS MET.
***DELTA T_**IN THIS CASE IS 33°-THE DEFFERENCE (DELTA) BETWEEN THE OUTSIDE 37° AND THE INSIDE 70°. GIVEN SOME CONSISTENCY IN THOSE 2 TEMPERATURES THERE CAN BE ASSIGNED TEMPERATURES AT EACH COMPONENT WITHIN THE WALL ASSEMBLY SOMEWHERE BETWEEN THE 2.



CALCING THE EXTERIOR INSULATION

***CALCING THE TEMPERATURE IN THE WALL_**KNOW THE R VALUE OF EACH LAYER AS A PERCENTAGE OF THE WHOLE WALL R AND APPORTION IT TO THE TEMPERATURE DIFFERENTIAL INSIDE AND OUT.
***EACH SURFACE_**CAN THEN BE ASSIGNED THAT SPECIFIC TEMPERATURE BETWEEN THE 68° INSIDE AND 37° OUTSIDE TEMPERATURES. THE VULNERABLE INSIDE FACE OF SHEATHING IS THE CONCERN. THE DEW POINT FALLS WITHIN THE EXTERIOR INSULATION WHICH BOTH OFFERS NO REAL SURFACE/MATERIAL FOR VAPOR TO CONDENSE ON/IN AND IS NOT SUBJECT TO DAMAGE.
***VARIABLES_**BUILDING SCIENCE AND ASSOCIATED ENGINEERS RECOGNIZE THIS IS A NECESSARILY AN APPROXIMATE CALCULATION. TOO MANY CHANGING VARIABLES. THE BACK UP PLAN IS MAKING SURE THE ASSEMBLY CAN DRY. IN THIS CASE TO THE INSIDE BECAUSE ALL THAT EXTERIOR INSULATION IS GOING TO RESIST DRYING TO THE OUTSIDE.



(3)PERM RATING LANGUAGES

***VAPOR IMPERMEABLE**_0.1 OR LESS
***VAPOR SEMI-IMPERMEABLE_**>0.1 TO 1.0
***VAPOR SEMI-PERMEABLE_**>1.0 TO 10
***VAPOR PERMEABLE_**>10

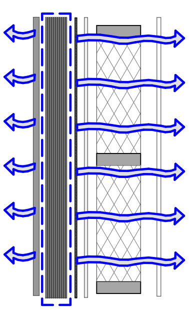
***CLASS I**_0.1 OR LESS
***CLASS II_**>0.1 TO 1.0
***CLASS III_**>1.0 TO 10

***VAPOR BARRIER**_0.1 OR LESS
***VAPOR RETARDER_**>0.1 TO 10

_check_SOME RATING ARE EASY TO FIND AND MANY OTHERS EITHER DIFFICULT TO FIND OR CONDITIONAL ON THICKNESSES, A TESTING ENVIRONMENT SPECIFICATION, A SPECIFIC MANUFACTURER.

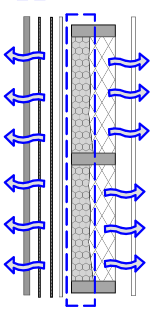
WALL ASSEMBLIES+PERM RATINGS

***WET WALLS**_IT IS RECOGNIZED THAT WALLS GET WET. THE INTENTIONS OF THE WRB AND AIR SEALING IN GENERAL IS TO KEEP THE WALL ASSEMBLY AS DRY AS POSSIBLE. BUT SOME LEVEL OF WATER/MOISTURE/VAPOR WILL GET IN AND A STRATEGY IS REQUIRED TO PERMIT THE WALL TO DRY.
***PERM RATINGS**_BASICALLY RATES HOW READILY VAPOR WILL PASS THRU A MATERIAL. THE BIGGER THE NUMBER THE MORE 'POUROUS' AND THE QUICKER VAPOR CAN PASS. ALL MATERIALS IN THE ASSEMBLY WILL HAVE AN ASSOCIATED PERM RATING. NOTED ABOVE, FINDING THE CORRECT PERM RATING CAN BE A CHORE.
***ASSEMBY LAYERS AND PERM RATINGS**_SO ONE WANTS TO PICK AN APPROPRIATE DRYING STATEGY, AND BE CONSCIOUS OF THE PERM RATINGS OF ASSEMBLY MATERIAL CHOICES SO THE PATH OF DRYING WILL NOT BE BLOCKED. AN ILLUSTRATION OF BLOCKING THAT DRYING POTENTIAL IS PUTTING A VINYL WALL COVERING ON THE INSIDE, OR USING A SEALED RUBBER LIKE MEMBRANE AS THE OUTSIDE WRB. NEITHER OF THESE MATERIAL CHOICES ARE A PROBLEM IF THEY ARE NOT BLOCKING VAPOR IN THE INTENDED DIRECTION OF DRYING.
***PERM RATING LANGUAGE**_UNFORTUNATELY THERE ARE 3 LANGUAGES USED IN QUALIFYING 'VAPOR PERMEANCE'. FOLLOW THE NUMBERS ABOVE TO SEE HOW THEY STACK UP.
***THE VAPOR BARRIER**_cka CLASS I, aka VAPOR IMPERMEABLE, IS THE REAL BLOCKER (BARRIER) REASONABLY REPRESENTED BY POLYETHYLENE FILM AND ALUMINUM FOIL. . BOTH POLYETHYLENE FILM AND ALUMINUM FOIL MAY BE INCORPORATED AS PART OF BOTH RIGID AND BATT INSULATION PRODUCTS TO UP THEIR IMPERMEANCE. EXAMPLE IS FOIL FACED POLYISO RIGID INSULATION WHICH THEN BECOMES A TRUE VAPOR BARRIER.
***THE VAPOR RETARDER**_IS EVERYTHING ELSE RATED FROM .1 AND UP. THE NUMBERS DEFINE THE PERMEANCE PERFORMANCE. THE LABELS ARE JUST WAYS TO TALK/CLASSIFY THEM. THE BELOW WAY TO THINK ABOUT WALL ASSEMBLY DRYING STRATEGIES USES THE PERM RATING TO HELP WITH PRODUCT SELECTIONS.



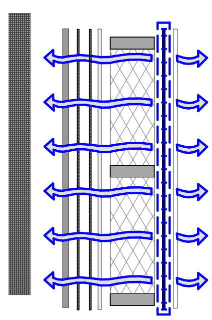
DRYING TO THE INSIDE

***EXTERIOR INSULATION**_MAY BE THE MOST IMPERMEABLE MATERIAL IN THE ASSEMBLY, WHICH WOULD HAVE THIS DRY MOSTLY TO THE INSIDE.
***RIGID PERM RATINGS**_THE TYPE OF RIGID, THE THICKNESS OF THE INSULATION, AND (MOST SIGNIFICANT) THE EXISTANCE OF A FACING, WILL ALL EFFECT THE RIGID PERM RATING-AND THESE VARY A LOT. THE FACED PRODUCTS MAY QUALIFY AS A VAPOR BARRIER. (CLASS I, VAPOR IMPERMEABLE)



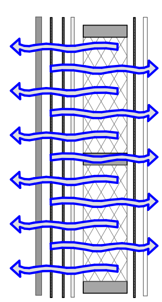
FLASH AND BATT INSULATION

***THE CLOSED CELL FOAM "FLASH"**_WILL LIKELY BE, AND WANTS TO BE, THE MOST IMPERMEABLE MATERIAL IN THE ASSEMBLY. DRYING IS THEN POSSIBLE IN BOTH DIRECTIONS.
***CHEMISTRY**_THE PERM VALUE OF THE 'FLASH' LIKELY NEEDS TO BE MANUFACTURER (AND THICKNESS) RESEARCHED. GENERIC PERM RATINGS MAY BE OFF A GOOD BIT.



DRYING TO THE OUTSIDE

***INTERIOR VAPOR BARRIER OR RETARDER**_VIABLE IN SOME COLDER CLIMATE ASSEMBLIES. SEE DRYING TO THE OUTSIDE ASSEMBLIES ZONES 4_C,5,6,7 (c6.19)
***SHORT HISTORY**_HUMIDITY IN THE WARMER INDOOR AIR TRYING TO GET OUT WILL BE 'BLOCKED' AT THE (BACKSIDE OF THE SHEETROCK). THE DEW POINT DISCUSSED IS MUTE BECAUSE THE MOISTURE IS MANAGED AT THE BARRIER. SOME SAY THIS VAPOR BARRIER CONTINUES TO BE A BAD APPROACH, WHICH INSPIRED THE DRY TO THE INSIDE THINKING FOR THESE SAME CLIMATE ZONES.



DRYING BOTH WAYS

***WARMER CLIMATES**_MAY NOT REQUIRE EITHER EXTERIOR INSULATION AND DO NOT WANT THE INTERIOR BARRIER/RETARDER AND THEREFORE SIMPLY HAVE NO INHERENT PERMEANCE TRAFFIC COP. IF THAT AVERAGE WINTER TEMPERATURES IN DEC, JAN, FEB ARE ABOVE 45^0 THEN THE DEW POINT PLANE INSIDE THE WALL IS NOT A DESIGN CRITERION. LET THE WALL BREATH.

FINDING THE CORRECT WALL ASSEMBLY

***BETTER RESOURCES**_ THIS STUFF GETS A LITTLE CONFUSING/COMPLICATED. BUILDING SCIENCE DIGS INTO THIS WITH FAR MORE KNOWLEDGE AND GUSTO. AS AN EXAMPLE OF REAL INFORMATION SEE BUILDING SCIENCE CORPORATION'S **BSD-106: UNDERSTANDING VAPOR BARRIERS.** THIS IS BUT ONE OF MANY ARTICLES ON WALL ASSEMBLY DYNAMICS. THIS PROJECT ACCEPTS THE LOGIC OF WHAT HAS BEEN PRESENTED THESE PAGES. THE PROBLEM WITH (ALL THIS) WATER/VAPOR DYNAMIC IN WALLS- AND FLOORS AND ROOFS- , IS THAT WITHOUT TEARING OPEN WALL CAVITIES (IN THE MIDDLE OF WINTER) WE JUST DON'T KNOW HOW THE ASSEMBLY IS PERFORMING.
***LOOKING BACK**_INSTRUCTIVE IS THE HISTORY OF CODE REQUIRED VAPOR BARRIERS IN THE FIRST ENERGY CONSERVATION 'MOVE,MENT' IN THE LATE 1970'S, 1980'S. VAPOR BARRIERS WERE REQUIRED ESSENTIALLY ON THE FACE OF STUDS BEHIND THE SHEETROCK AND LOT OF MOISTURE/MILDEW WAS SHOWING UP CAUSING A MESS. THE PROBLEM WAS AT ITS WORSTG IN THE HOT HUMID CLIMATES. STANDARDS WERE RELAXED, PERMITTING VAPOR RETARDERS, BUT WITH CAUTION AND DOUBT RAMPANT. THIS REPRESENTED A LACK OF KNOWLEDGE ABOUT THE INSULATED CONSTRUCTION ASSEMBLY AND HELPED BRING ABOUT THE 'BUILDING SCIENCE' FOCUS.