FRAME FLOORS c5

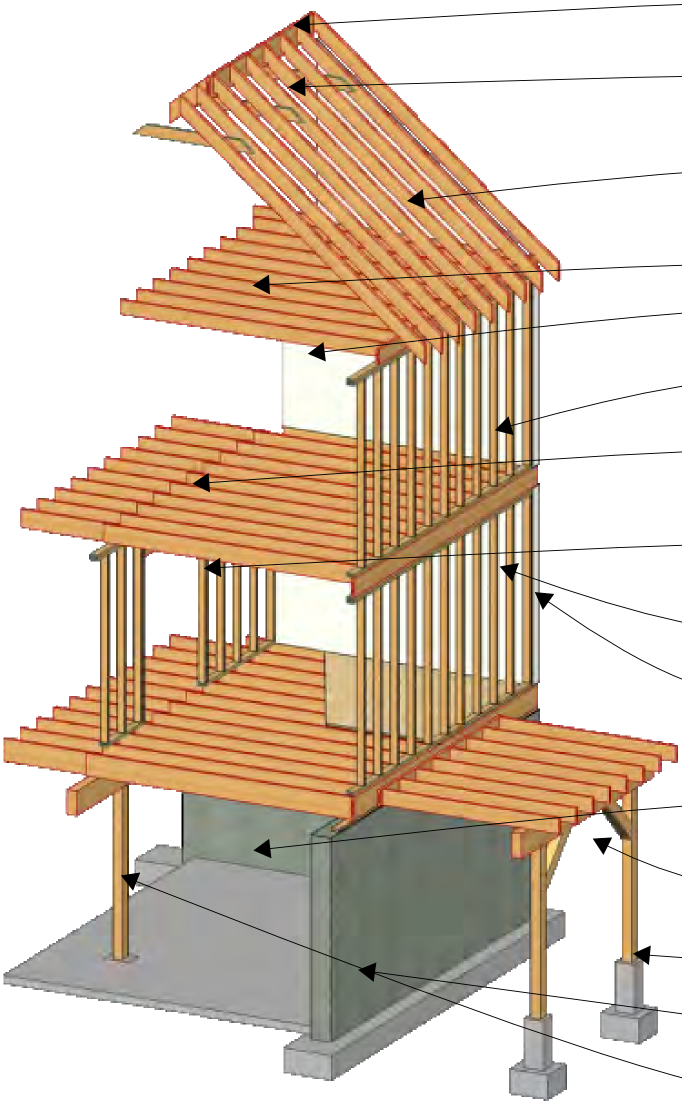
STICK FRAMING

***FLOORS/WALLS ROOFS_**MOST RESIDENTIAL HOME CONSTRUCTION EMPLOYS WOOD FRAME CONSTRUCTION FROM THE FOUNDATION PACKAGE UP. IT IS SOMETIMES CALLED 'STICK' FRAMING AS MANY/MOST MEMBERS ARE STICK LIKE (JOISTS/STUDS/RAFTERS). IT INVOLVES THE SELECTING AND ASSEMBLING OF THESE MANY STICKS INTO FLOORS, WALLS & ROOFS.

***THE COMPONENTS IN STICK FRAMING_**THE APPROACH IN THIS SECTION WILL FIRST OVERVIEW THE STICK COMPONENT CHARACTERISTICS AND CAPABILTIES AND THEN ASSEMBLE THEM INTO THEIR OWN FUNCTIONING SYSTEM. **c5** FIRST THE FLOORS. CHAPTER **c6** WILL DEAL WITH WALLS, CHAPTER **c7** WITH ROOFS AND **c8** WITH THE 3 PLANES ASSEMBLED AS A UNIFIED STRUCTURAL SHELL

***THE STRUCTURE_**IT IS USUAL AND REASONABLE TO FIRST DESIGN A STICK FRAME STRUCTURE TO RESIST ALL LOADING SO IT WILL REMAIN STANDING. OTHER JOBS AND CONSIDERATIONS CERTAINLY EXIST AND REQUIRE ATTENTION BUT THE STRUCTURE IS THE BASE LINE AND THE PRIMARY CONTENT THIS CHAPTER.

DIMENSIONAL LUMBER STICK FRAMING PARTS



*RIDGE BOARD_rafters are framed to and align on each side of the ridge board. The ridge board is a brace, not a beam.

*COLLAR TIES_one of the roof ties. These tie the rafter members one side to the other and help resist wind generated movement. 2x4's at 48" oc is the min requirement.

*RAFTERS_2x6,8,10,12 based on structure and possible insulation requirements. Spaced usually at 16" or 24" oc. Span from ridge board to wall plate.

*ATTIC FLOOR DECK_2x members as required, based on span.

**NON BEARING END WALLS__on both floors and in gable end above attic floor do not show as individual studs for clarity only.

*UPPER WALL FRAMING _2x4 or 6 walls with 1 bottom plate and 2 top plates. Possible blocking does not show.

*UPPER FLOOR DECK_2x10 or 2x12 joist members, lapped and bearing on center basement beam. Osb floor sheathing. Perimeter joist all the way around. aka band joist, aka rim joist, aka box band.

*CENTER BEARING WALL_2x4 center wall with single bottom plate and double top plate with a headed opening. Upper floor joists show lapped and bearing on this wall.

*MAIN WALL FRAMING _2x4 or 6 walls with 1 bottom plate and 2 top plates. Possible blocking does not show.

*MAIN FLOOR DECK_2x10 or 2x12 joist members, lapped and bearing on center basement beam. Osb floor sheathing. Perimeter joist all the way around. aka band joist, aka rim joist, aka box band.

*EXTERIOR DECK _2x8 or 2x10 treated lumber joists cantilevered over a deck beam, and attached to a 2x8 or 2x10 treated legder at the house plane.

*EXTERIOR DECK BEAM/POST/BRACES_a drop built-up beam sitting on 4x4, or 6x6 treated posts. Braces shown are often required.

*EXTERIOR DECK PIERS AND PIER FOOTINGS_concrete footings with piers to above grade.

*FOUNDATION_full ht basement wall supported by the continuous perimeter concrete footing.

*INTERIOR BEARING COMPONENTS_a wood support post is shown supporting a drop built-up center wood beam.

GRAVITY LOADING

***DEFINED_**TOTAL GRAVITY LOADS CONSISTS OF LIVE LOADS PLUS DEAD LOADS. IT IS QUANTIFIABLE, AND ALL HEADS IN ONE DIRECTION-DOWN. THESE ARE THE MOST PREDICTABLE AND EASIEST TO DESIGN FOR.

LATERAL LOADING

***DEFINED_**AS CONCERNS FLOOR, WALL, ROOF FRAMING LATERAL LOADING IS WIND BASED. IT IS CONSIDERABLY MORE COMPLICATED THAN GRAVITY LOADING, AND IS MORE INTERDEPENDENT. c8 WILL OVERVIEW WIND LOADING ON THE ENTIRE STRUCTURAL SHELL.

LIVE GRAVITY LOADS

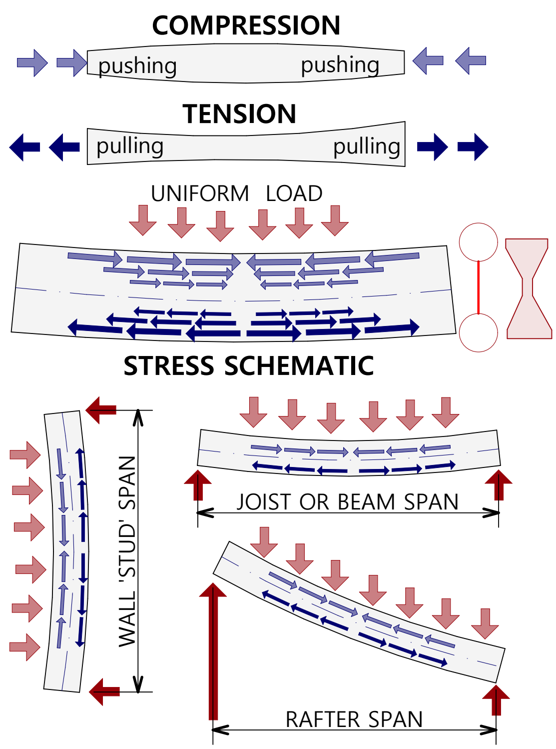
*****ARE TEMPORARY AND OR DYNAMIC. OCCUPANTS. MOVEABLE OBJECTS AND FURNITURE. AND SNOW ON THE ROOF PLANE.

DEAD GRAVITY LOADS

*****ARE PERMANENT AND STATIC. WEIGHT OF THE STRUCTURE AND ANY PERMANAENTLY FIXED OBJECTS AND FURNITURE.

COMMON STRUCTURAL TERMS

*TL_TOTAL LOAD
*DL_DEAD LOAD
*LL_LIVE LOAD
*PSF_(POUNDS) PER SQUARE FT
*PLF_(POUNDS) PER LINEAL FT
*P_POUNDS
*TW_TRIBUTARY WIDTH
*TA_TRIBUTARY AREA



THE BEAM IDEA IN FRAME CONSTRUCTION

***THE 'BEAM' IDEA**_ WAS INTRODUCED IN DISCUSSING REINFORCED CONCRETE. THIS SAME PRINCIPLE IS THE CONTROLLING FACTOR WITH VIRTUALLY ALL HORIZONTAL 'STICK' FRAMING MEMBERS. PURLINS, JOISTS, BEAMS, GIRDERS. IT IS ALSO TRUE WITH ANY SLOPED ROOF MEMBERS INCLUDING ROOF RAFTERS, HIPS, VALLEYS. IT CAN BE TRUE OF VERTICAL MEMBERS EXPERIENCING HORIZONTAL WIND LOADS. ALL ARE SUBJECT TO THIS BEAM IDEA AND BEHAVIOR. IT IS WORTHWHILE INTRODUCING THIS FIRST AND FOLLOW ITS APPLICATION IN FLOORS, WALLS AND ROOFS

***COMPRESSION & TENSION**_THE STRESS SCHEMATIC ILLUSTRATES THE UPPER HALF OF THE MEMBER IN COMPRESSION (PUSHING), AND THE LOWER HALF IN TENSION (PULLING). THE COMPRESSION IS GREATEST AT THE VERY TOP. THE TENSION IS GREATEST AT THE VERY BOTTOM. THE MID LINE IS REFERRED TO AS THE NEUTRAL AXIS-AND EXPERIENCES NO COMPRESSION OR TENSION. THERE IS SOME SHEAR STRESS AT THAT MIP POINT- BUT NOT GERMANE TO THIS EXERCISE. THE DOODLES ON THE RIGHT IMPLY A MEMBER SHAPE THAT RESPONDS TO THIS NORMAL LOADING.

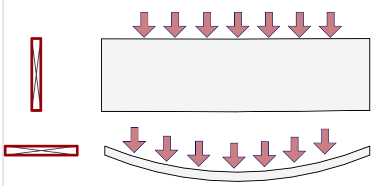
***THE LOAD**_LOADS ARE QUALIFIED AND QUANTIFIED AS LIVE LOADS (**LL**) AND DEAD LOADS (**DL**). TOGETHER THEY ARE REFERRED TO AS TOTAL LOAD (**TL**)

***LIVE LOADS**_ARE TEMPORARY AND OR DYNAMIC SUCH AS **OCCUPANTS**, MOVEABLE OBJECTS AND FURNITURE, WIND, SNOW.

***DEAD LOADS**_ARE PERMANENT AND STATIC. WEIGHT OF THE STRUCTURE AND ANY PERMANAENTLY FIXED OBJECTS AND FURNITURE.

***THS SPAN**_IS THE DISTANCE FROM SUPPORT TO SUPPORT.

***CALCULATION & ULTIMATE MEMBER SELECTION**_IS BASED ON THE TOTAL LOAD IMPOSED ON A MEMBER WITH A GIVEN SPAN. MORE LOAD AND OR A LONGER SPAN REQUIRES MORE RESISTANCE THERFORE A 'STRONGER' MEMBER.

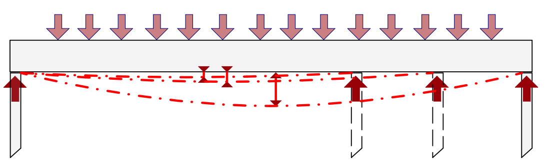


PERFORMANCE UNDER LOAD

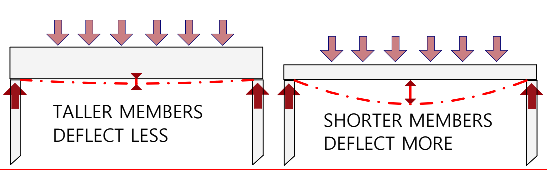
***EXPERIMENT**_THIS OFT SITED EXPERIMENT IS A VERY EFFECTIVE ONE. TAKE A 2X4 OR 2X6 AND SPAN IT BETWEEN SUPPORTS (LIKE CONCRETE BLOCKS OR A PILE OF BOOKS). TURN IT ON EDGE & STAND ON IT AND TURN IT FLAT AND STAND ON IT. WHEN ON EDGE THE MEMBER WILL BEND LESS, WHEN FLAT IT WILL BEND MORE. IT IS THE SAME MEMBER AND CROSS SECTIONAL AREA.

***DEPTH FACTOR**_SO THE INCREASED VERTICAL DIMENSION IN THE DIRECTION OF THE LOAD MATTERS.

***COMMON SENSE ENGINEERING**_TRYING TO STAY CLEAR OF ANY ENGINEERING MATH THESE BELOW EXERCISES ARE INTENDED TO SET THE ROLE/IMPORTANCE OF DEPTH IN MEMBERS RESISTING GRAVITY LOADS.



*LONGER SPANS RESULT IN GREATER DEFLECTION
*DEFLECTION INCREASES EXPONENTIALLY AS SPAN INCREASES



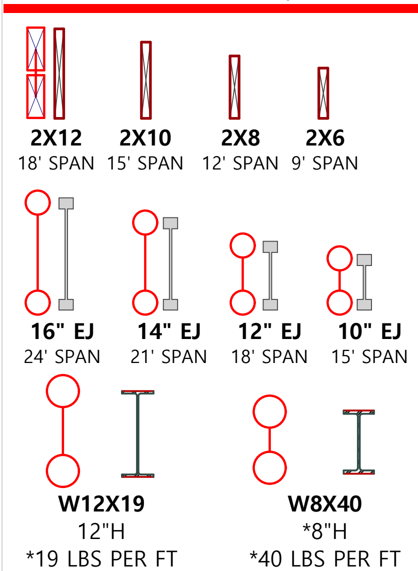
RELATIONSHIP OF LOAD, SPAN & DEFLECTION

***THE LOAD**_TYPICAL FRAMING LOADS ARE CALCULATED AS UNIFORM OR ACTING EQUALLY FROM ONE END TO THE OTHER. THESE 3 ILLUSTRATIONS SHOW THAT UNIFORM LOADING.

***THE SPAN**_IS THE DISTANCE FROM SUPPORT TO SUPPORT.

***DEFLECTION**_IS THE AMOUNT OF 'SAG' OR DROP A MEMBER MAY EXPERIENCE WHEN UNDER LOAD. WE INTUITIVELY UNDERSTAND THAT BOTH WOOD AND STEEL AS MATERIALS HAVE THE CAPACITY TO BEND (SAG) WITHOUT NECESSARILY FAILING. DEFLECTION LIMITS ARE INVOLVED IN MOST MEMBER SELECTIONS. DEFLECTION IS OFTEN THE CONTROLLING FACTOR IN MEMBER SELECTION.

***OBSERVATION**_GIVEN THE SAME LOADING AND THE SAME MEMBER TYPE, LONGER SPANS WILL DEFLECT MORE. SHORTER SPANS WILL DEFLECT LESS. TALLER MEMBERS ARE STIFFER AND DEFLECT LESS. SHORTER MEMBERS ARE NOT AS STIFF, AND WILL DEFLECT MORE.



DEPTH & SPAN

DIMENSIONAL LUMBER

***THE CONVENTIONAL JOIST**_SPANS INCREASES WITH DEPTH

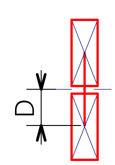
ENGINEERED JOISTS

***THE ENGINEERED JOIST**_SPANS SIMILARLY INCREASE WITH DEPTH. GREATER DEPTHS CAN BE MANUFACTURED WITH LESS VOLUME & WEIGHT

STEEL

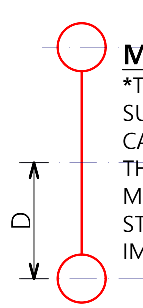
***THE I BEAM**_THIS COMPARISON ILLUSTRATES THE INCREASED EFFICIENCY WITH GREATER DEPTH. THE 12" BEAM CAN HANDLE THE SAME LOAD WITH 50% LESS STEEL. CHEAPER AND LIGHTER.

EFFIECIENCY



MEAT x DISTANCE

*WITH CONVENTIONAL OR RECTANGULAR MEMBER SECTIONS THE (CENTER OF THE) MEAT STAYS CLOSER TO THAT NEUTRAL AXIS SO THE MEAT TIMES DISTANCE IS LIMITED.



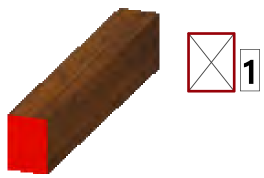
MEAT x DISTANCE

*THIS VERTICAL BARBELL SYMBOL IS SUGGESTING A STRUCTURAL MEMBER THAT CAN LOCATE ITS MEAT A DISTANCE FROM THE NEUTRAL AXIS. THE AMOUNT OF THE MEAT AND THE DISTANCE DETERMINE THE STRENGTH/STIFFNESS. THIS SYMBOL IS IMPLYING AN EFFICIENT USE OF MATERIALS

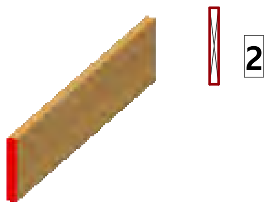
OVERVIEW OF JOIST & BEAM MEMBER TYPES

***STRUCTURE FIRST**_THE BELOW SUMMARY COMMENTS ON THESE MEMBER TYPES ARE FURTHER DESCRIBING THESE BASED MOSTLY ON STRUCTURAL CAPABILITY AND EFFICIENCY. MANY OTHER FACTORS COME INTO PLAY IN MAKING THE FINAL SELECTIONS/DECISONS AS WILL BE OUTLINED.

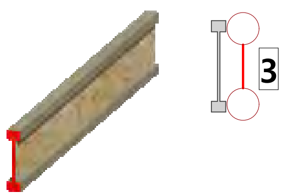
BEAM SHAPE & EFFICIENCY- RESONDING TO THE COMPRESSION/TENSION RULES



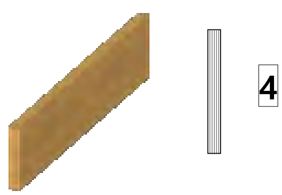
1*TIMBERS_TRADITION TIMBERS FOR POST AND BEAM CONSTRUCTION ARE PROPORTIONALLY WIDER AND NOT SO TALL. THEIR DIMENSIONAL LIMITATIONS WERE A FUNCTION OF THE TREE THEY CAME FROM, AND THEIR WEIGHT. THEY ARE NOT STRUCTURALLY EFFICIENT AS THERE IS TOO MUCH MIDDLE WEIGHT & MASS THAT CONTRIBUTES LITTLE. BUT THEY SURE LOOK GOOD AND SUBSTANTIAL, AND WANT TO BE EXPOSED BECAUSE OF THAT.



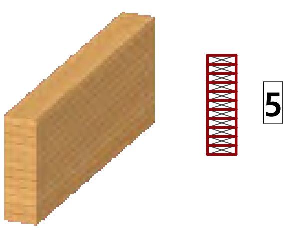
2*'CONVENTIONAL' LUMBER_REFERS TO OUR 2X4'S,2X6'S,2X8'S,2X10'S, 2X12'S. THEY ARE ALL 1 1/2" WIDE. THEY ARE INTENDED FOR 'REPETITIVE USE' OR SPACED AT EVERY (TYPICALLY) 16". THE CLOSE SPACING REDUCES THE LOAD PER MEMBER AND ALLOWS THESE NARROWER MEMBERS TO DO THE JOB. IN REPETITIVE USE THEY CREATE A REASONABLE EFFICIENT SYSTEM, AND A VERY FLEXIBLE AND FORGIVING ONE.



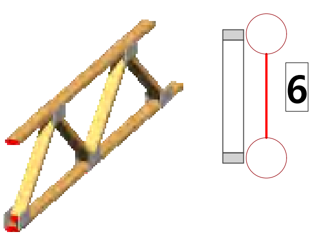
3*ENGINEERED JOISTS_ALSO INTENDED FOR 'REPETITIVE USE'. THESE MANUFACTURED JOISTS HAVE TOP AND BOTTOM MEAT (FLANGES) SEPARATED BY A THIN AND LIGHT WEIGHT WEB. EXTREMELY EFFICIENT WEIGHT TO STRENGTH. AND MANUFACTURED FROM A HIGH PERCENTAGE OF SCRAP WOODS- SO THEY ALSO GET A HIGH SUSTAINABLE RATING. BECAUSE OF THE LIGHT WEIGHT AND THE FACT THEY ARE MANUFACTURED DEPTHS UP TO 20" ARE AVAILABLE SPANNING AS MUCH AS 28' +/-. ONE ACCURATE CRITICISM OF THE ENGINEERED JOIST PUSHING ITS SPAN LIMITS IS A BOUNCINESS N THE FLOOR ASEMBLY.



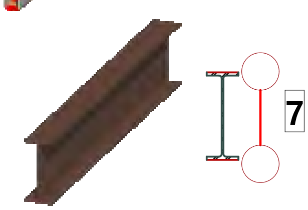
4*ENGINEERED BEAMS_THESE ARE NOT INTENDED/DESIGNED AS REPETITIVE MEMBER JOISTS. BUT THESE MANUFACTURED BEAMS DO NOT OFFER A STRUCTURAL EFFICIENCY AS A FUNCTION OF OUR 'SHAPE MODEL' AS THEY ARE PHYSICALLY RECTANGULAR, BUT THEY DO OFFER AN EFFICIENCY BASED ON THE MANUFACTURED ORIENTATION OF THE (SCRAP) WOOD FIBER PLACEMENT. ON A STRENGTH PER CROSS SECTION AREA BASIS THEY ARE 2-3 TIMES MORE EFFICIENT THAN DIMENSIONAL LUMBER BECAUSE OF THAT FIBER PLACEMENT.



5*GLULAM BEAMS_FARE SIMPLE AND INTERESTING WORKHORSES WITH SOME VISUAL APPEAL. MADE OF STACKED 2X4, AND 2X6'S (MOSTLY) AND GLUED TOGETHER UNDER PRESSURE. SEVERAL GRADES THE 2X BASE MATERIAL IS AVAILABLE WHICH EFFECTS THE ULTIMAT STRENGTH AND APPEARANCE OF THE MEMBER. PRETTY COMPARABLE TO THE LVL IN SPAN PER SIZE, AND MATERIAL EFICIENT BECAUSE OF THEM BEING MADE WITH SMALLER CROSS SECTIONS AND END JOINED WITHIN THE MEMBER LENGTH. THESE ARE USED AS STANDALONE BEAMS AND AS BIGGER SCALE REPETICVE MEMBERS INTENDED TO BE EXPOSED AND SEEN.



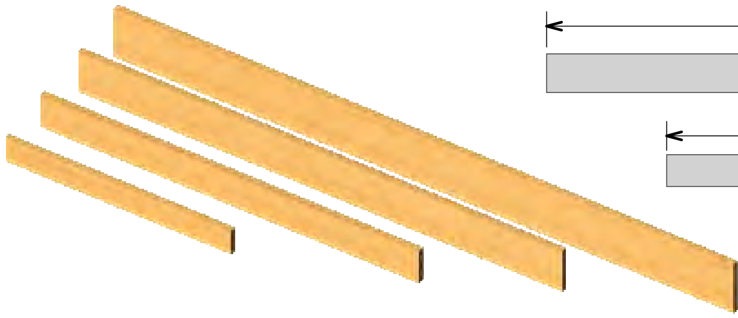
6*THE TRUSS_THE CONCEPT OF THE TRUSS IS SEPARATING BY DISTANCE THE TOP MEAT (CALLED A CORD IN THE TRUSS LANGUAGE) FROM THE BOTTOM MEAT (CORD) WITH 'WEB' MEMBERS LACING TOP AND BOTTOM CORDS TOGETHER. DEPTH OF A TRUSS MEMBER IS SORT OF UNLIMITED (LIMTED BY TRANSPORTATION RESTRICTIONS MORE THAN MANUFACTURING ONES) AND IS CREATED WITH MINIMAL MATERIAL BULK. THE STRUCTURAL PRINCIPLES ARE MORE COMPLICATED WITH A TRUSS DESIGN THAN OUR MEAT X DISTANCE REFERENCE, BUT EFFICIENCY AND GREATER DEPTHS, GREATER SPANS, AND LIGHT WEIGHT IS VERY MUCH THE RESULT. RESIDENTIAL REPETITIVE MEMBERS RANGE FROM 12" DEEP TO 24" DEEP AND ARE FREQUENTLY SPACED FARTHER APART (19.2" OR 24") THAN THE STANDARD 16" OF DIMENSIONAL LUMBER. THERE ARE MANY TRUSS TYPES AND CONSTRUCTIONS BUT MANY/MOST RESIDENTIAL TRUSSES ARE CONSTRUCTED WITH 2X4'S WITH LIGHT WEIGHT STEEL CONNECTOR PLATES HOLDING ALL THE PIECES TOGETHER.

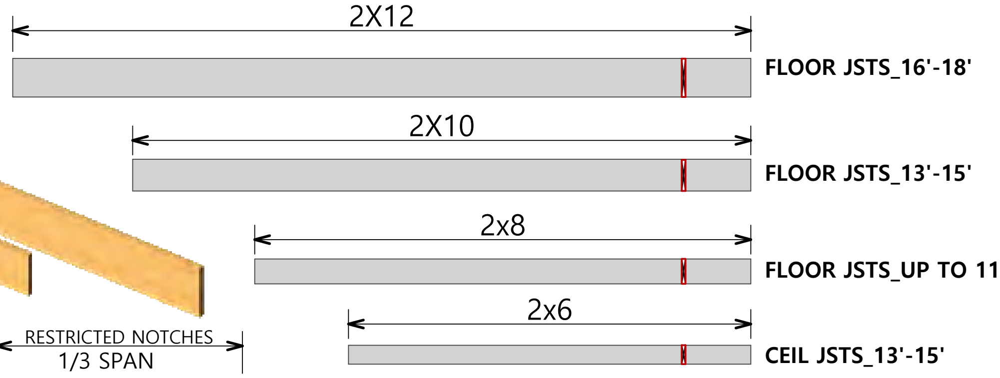


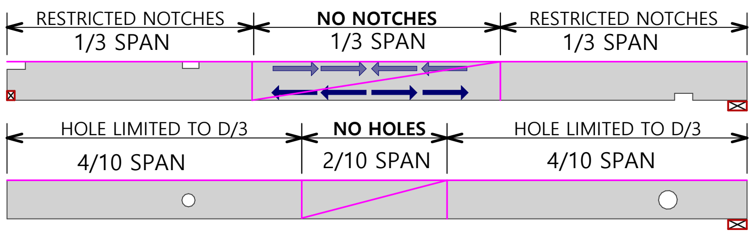
7*STEEL_THE STEEL WIDE FLANGE OR I BEAM IS INCREDIBLY EFFICIENT STRUCTURALLY. THE FLANGES TOP (COMPRESSION) AND BOTTOM (TENSION) WASTE LITTLE MATERIAL. BOTH SHAPE AND THE SIGNIFICANT PSI STRUCTURAL RATINGS IN BOTH TENSION & COMPRESSION MAKE THIS A CHOICE WHEN SPANS ARE LONG AND LOADS ARE HIGH.

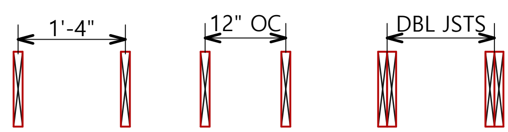
DIMENSIONAL LUMBER CHARACTERISTICS

***NOMINAL SIZE/ACTUAL SIZE**_2X MEMBERS(NOMINAL SIZE) ARE ACTUALLY 1 1/2" X 1/2" LESS THAN NOMINAL DEPTH.
***SPAN/WEIGHT/EFFICIENCY**_NOTED ALREADY THE INHERENT LIMITED STRUCTURAL EFFICIENCY OF THE RECTANGULAR SHAPE OF THE 2X. SPAN TO WEIGHT RELATIONSHIP IS NOT GREAT. BUT 1 OR 2 GUYS CAN MOVE AROUND PIECES AS REQUIRED WITHOUT MUCH TROUBLE. THE SPAN LIMITATIONS LIMIT LENGTHS WHICH LIMITS WEIGHT.
***FLEXIBILITY_IS** THE BEST BECAUSE THEY CAN BE TRIMMED/BEVELED/CHOPPED, NAILED, SCREWED, GLUED ANYWHERE AND THE WOOD FIBRES ARE THE SAME. THIS FLEXIBILITY, ALONG WITH A VERY REASONABLE COST MAKE CONVENTIONAL LUMBER A DEFAULT CHOICE. WHEN REQUIRED/DESIRED SPANS EXCEED THAT 16'-18' 2X12 COMFORT ZONE, THEN OTHER OPTIONS COME INTO PLAY









CUTTING EM UP

***HOLY COW**_BELIEVE IT OR NOT NOTCHES AND HOLES GET CUT INTO JOISTS ALL THE TIME. THE USUAL CAUSE IS ELECTRICAL & PLUMBING INSTALLERS FINDING THE MOST DIRECT ROUTE- THRU THE JOIST. THE CODE [R502.8] HAS FORTUNATELY DIAGRAMED THE EXACT LIMITATIONS- AND IF FOLLOWED PRESENT NO STRUCTURAL LIABILITY. SOME OTHER CONDITIONS EXIST IN THE CODE.
***NOTCHES**_AT THE END THIRD OF THE JOIST WITH DEPTH LIMITED TO 1/4 JOIST DEPTH.
***CUTOUTS/HOLES**_AT THE END 4/10THS OF THE JOIST. MAX HOLE D/3.
***LIMITATIONS**_WASTE LINES NEED CAREFUL CALCULATION (THEY NEED TO SLOPE). HVAC NOTCHES/HOLES NOT POSSIBLE.

SPACING

***COMMON**_16" ON CENTER (OC) IS BY FAR THE MOST COMMON SPACING FOR DIMENSIONAL LUMBER FOR FLOOR JOISTS, CEILING JOISTS, AND ROOF RAFTERS. THEIR LIMITED SPAN CAPABILITIES MAKE WIDER SPACING NOT ALWAYS POSSIBLE.
***SPECIAL CONDITIONS**_WHEN A SPAN OR CONDITION CALLS IT IS SIMPLE TO DECREASE SPACING-TO 12" OR EVEN 8", OR DOUBLE UP THE JOISTS.

DIMENSIONAL LUMBER SPAN TABLES

***CODE CHARTS**_ARE NOT INCLUDED BELOW ONLY BECAUSE THEY REQUIRE MUCH MORE PAPER SPACE THAN BELOW CHART. SEE CHAPTER 5 [TABLES 502.3.1(1), 502.3.1(2) FOR FLOOR FRAMING FOR 40# LIVE LOAD (ALL LIVING SPACES), AND 30# LIVE LOADS (SLEEPING SPACES ONLY). THE CODE HAS ADDITONAL CHARTS FOR CEILING JOISTS AND ROOF RAFTERS IN CHAPTER 8- ROOF AND CEILING CONSTRUCTION.
***CHART BELOW**_IS BY THE WWPA (WESTERN WOOD PRODUCTS ASSOCIATION) AND IS MORE COMPACT. IT IS REPRESENTING A VERY STANDARD LOAD CONDITION OF 40# LIVE LOAD (ALL LIVING AREAS), 10# DEAD LOAD (A STANDARD LIGHTER LOAD), AND L/360 DEFLECTION LIMIT (STANDARD FOR FLOOR LOADING VALID UP TO 16' SPANS AND REQUIRING CONDITIONAL EXAMINATION OVER 16').
***ADDITIONAL CHARTS**_OTHER 'SISTER' CHARTS EXIST WITH OTHER LIVE AND DEAD LOADING COVERING ALL RESIDENTIAL SITUATIONS.
***SPECIES & GRADE OF WOOD**_SPECIES IS REGIONAL. TIMBER REGIONS MAY OFFER A FEW CHOICES. TIMBER BARREN REGIONS MAY OFFER ONLY 1. THE #2 GRADE IS CODE REQUIRED AND USUALLY WHAT IS STOCKED AT THE BUILDING SUPPLY STORE. THE SPAN CHART INDICATES THE ADDED SPAN CAPACITY OF THE BETTER GRADES. BETTER GRADES, IF AVAILABLE, WILL BE STRAIGHTER AND (MORE) KNOT FREE, AND MORE COSTLY.

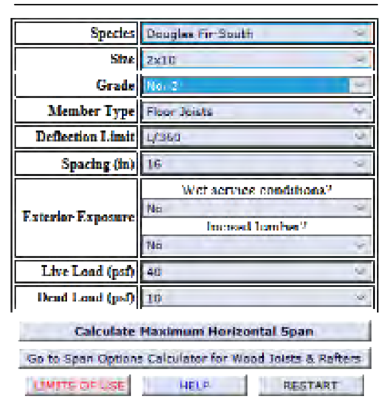
FLOOR JOISTS **40# LIVE LOAD 10# DEAD LOAD L/360**

Table FJ-3

Design Criteria: *Strength* - 40 lbs. per sq. ft. live load, plus 10 lbs. per sq. ft. dead load.
Deflection - Limited in span in inches divided by 360 for live load only.

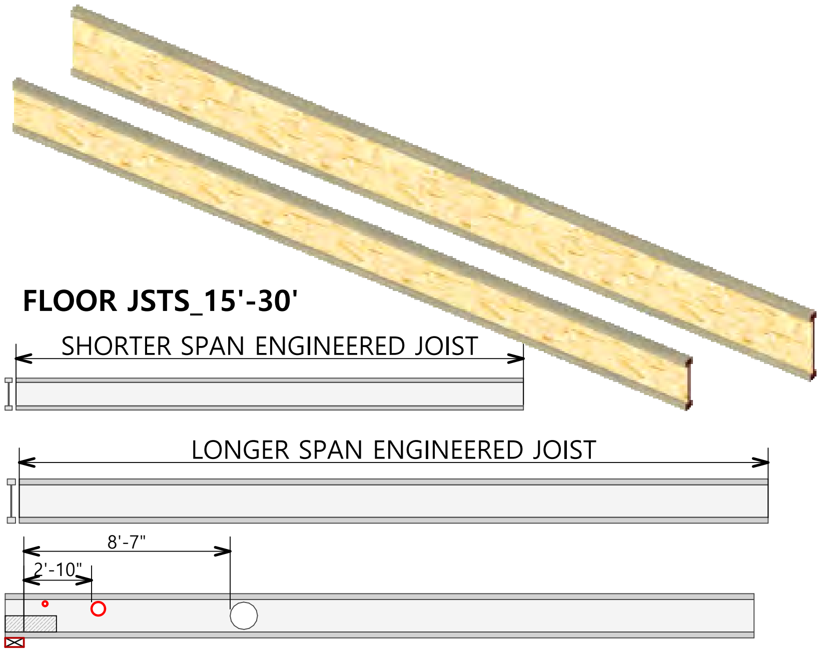
		Span (feet and inches)															
		2 x 6				2 x 8				2 x 10				2 x 12			
		spacing on center															
Species or Group	Grade	12"	16"	19.2"	24"	12"	16"	19.2"	24"	12"	16"	19.2"	24"	12"	16"	19.2"	24"
Douglas Fir-Larch	Sel. Struc.	11-4	10-4	9-8	9-0	15-0	13-7	12-10	11-11	19-1	17-4	16-4	15-2	23-3	21-1	19-10	18-5
	No.1 & Btr.	11-2	10-2	9-6	8-10	14-8	13-4	12-7	11-8	19-9	17-0	16-0	14-9	22-10	20-9	19-1	17-1
	No.1	10-11	9-11	9-4	8-8	14-5	13-1	12-4	11-0	18-5	16-5	15-0	13-5	22-0	19-1	17-5	15-7
	No.2	10-9	9-9	9-2	8-3	14-2	12-9	11-8	10-5	18-0	15-7	14-3	12-9	20-11	18-1	16-6	14-9
	No.3	8-11	7-8	7-0	6-3	11-3	9-9	8-11	8-0	13-9	11-11	10-11	9-9	16-0	13-10	12-7	11-3
Douglas Fir-South	Sel. Struc.	10-3	9-4	8-9	8-2	13-6	12-3	11-7	10-9	17-3	15-8	14-9	13-8	21-0	19-1	17-11	16-8
	No.1	10-0	9-1	8-7	7-11	13-2	12-0	11-3	10-6	16-10	15-3	14-5	12-11	20-6	18-4	16-9	15-0
	No.2	9-9	8-10	8-4	7-9	12-10	11-8	11-0	10-2	16-5	14-11	13-10	12-5	19-11	17-7	16-1	14-4
	No.3	8-8	7-6	6-10	6-2	11-0	9-6	8-8	7-9	13-5	11-8	10-7	9-6	15-7	13-6	12-4	11-0
Hem-Fir	Sel. Struc.	10-9	9-9	9-2	8-5	14-2	12-10	12-1	11-3	18-0	16-5	15-5	14-4	21-11	19-11	18-9	17-5
	No.1 & Btr.	10-6	9-6	9-0	8-4	13-10	12-7	11-10	11-0	17-9	16-0	15-1	14-0	21-6	19-6	18-3	16-4
	No.1	10-6	9-6	9-0	8-4	13-10	12-7	11-10	10-10	17-8	16-0	14-10	13-3	21-6	18-10	17-2	15-5
	No.2	10-0	9-1	8-7	7-11	13-2	12-0	11-3	10-2	16-10	15-2	13-10	12-5	20-4	17-7	16-1	14-4
	No.3	8-8	7-6	6-10	6-2	11-0	9-6	8-8	7-9	13-5	11-8	10-7	9-6	15-7	13-6	12-4	11-0
Spruce-Pine-Fir (South)	Sel. Struc.	10-0	9-1	8-7	7-11	13-2	12-0	11-3	10-6	16-10	15-3	14-5	13-4	20-6	18-7	17-6	16-3
	No.1	9-9	8-10	8-4	7-9	12-10	11-8	11-0	10-2	16-5	14-11	14-0	12-7	19-11	17-10	16-3	14-7
	No.2	9-6	8-7	8-1	7-6	12-6	11-4	10-8	9-8	15-11	14-6	13-3	11-10	19-4	16-10	15-4	13-9
	No.3	8-3	7-2	6-6	5-10	10-5	9-0	8-3	7-5	12-9	11-0	10-1	9-0	14-9	12-10	11-8	10-5

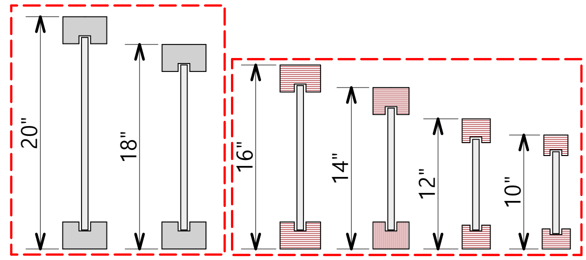
INTERACTIVE CHART by the AMERICAN WOOD COUNCIL



ENGINEERED JOIST CHARACTERISTICS

***LIGHT, STRAIGHT, EFFICIENT, CONSISTENT**_THESE JOISTS ARE ENGINEERED/MANUFACTURED AND THEREFORE PREDICTABLE. IN OVERVIEW THEY ARE A LITTLE LESS FLEXIBLE AND A LITTLE MORE EXPENSIVE THAN DIMENSIONAL LUMBER. THERE ARE WELL DOCUMENTED (MANUFACTURER) RULES ABOUT HANDLING/INSTALLATION ETC.

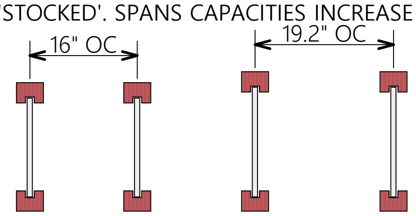




SERIES-LIGHT DUTY TO HEAVY DUTY

***MANUFACTURERS**_THERE ARE A HALF DOZEN + MAJOR MANUFACTURERES MAKING THE ENGINEERED JOISTS. EACH HAVE THEIR OWN 'SERIES' THAT SEQUENTIALLY INCREASE SPAN CAPACITY BY ALTERING (PRIMARILY) THE DIMENSIONS AND MATERIAL CONSTRUCT FOR THE FLANGES. SOME USE ENGINEERED/LAYERED PLYS AND SOME USE CONVENTIONAL LUMBER.

***DEPTHS**_NOMINAL 10" TO 24" DEPTHS MAY BE AVAILABLE. PROBABLY 12" AND 16" ARE THE MORE WIDELY USED AND 'STOCKED'. SPANS CAPACITIES INCREASE WITH DEPTH.



CUTTING EM UP

***DESIGNED FOR IT**_THE STRUCTURAL NATURE OF THIS ENGINEERED PRODUCT DO ALLOW CUTOUTS IN THE WEB.

***CUTOUTS/HOLES**_MANUFACTURERS HAVE THEIR PROPRIETARY PERMISSIONS FOR FOR CUTOUTS IN THE WEB THAT ARE MUCH MORE GENEROUS THAN WITH CONVENTIONAL LUMBER. IN GENERAL LARGER HOLES ARE PERMITTED THE FARTHER FROM THE SUPPORT. WASTE LINES AND VENT DUCTING CAN PASS THRU FLEXIBLY. HVAC DUCTING THROUGH THESE IS LIMITED BY MEMBER HT AND DUCT DEPTH OR DIAMETER, SO ITS ALL DIMENSIONALLY CONDITIONAL. **DO NOT ASSUME** HVAC DUCTING WILL FIT

***NO NOTCHES IN THE FLANGES**_THE ENGINEERED JOIST NEEDS THOSE TOP AND BOTTOM FLANGES TO DO ITS JOB. NO TOP AND BOTTOM NOTCHES PERMITTED

SPACING

***COMMON**_16" AND 19.2" CENTERS (OC) ARE MOST COMMON SPACING FOR ENGINEERED JSTS. THE 19.2" SPACING CAN BE MORE ECONOMICAL WITH NO NOTICABLE DOWNSIDE.

***STOCK SELECTIONS**_LOCAL AVAILABILITY OF SIZES AND SERIES MAY DECIDE THE BEST (MOST ECONOMICAL) SELECTION, PARTICULARLY IF SELECTION FROM 'STOCK' IS DEEMED PRACTICAL. FOR EXAMPLE SOME MAY 'STOCK' 12 AND 16" DEPTHS ONLY IN A LIGHTER WEIGHT SERIES.

ENGINEERED JOIST PROPRIETARY SPAN TABLES

***CONCEPT THE SAME**_THE SERIES (COMPARABLE TO SELECTING THE WOOD SPECIES), THE JOIST DEPTH, THE SPACING ARE CROSS REFERENCED AND A MAXIMUM SPAN IS PRESENTED.

***DEFLECTION & 'PERFORMANCE'**_A CONSEQUENCE OF THE EFFICIENCY OF THE ENGINEERED JOIST IS A CHARACTERISTIC OF BEING 'HIGH STRUNG'. THEY FEEL BOUNCY & EVEN SOUND HIGHER PITCHED THAN DIMENSIONAL LUMBER WHEN WALKED ON. THIS IS A CONDITION OF A MORE EFFICIENT PRODUCT. THE INDUSTRY THAT MAKES THESE ADRESSED THIS ISSUE BY EXPANDING THE DEFLECTION LIMIT CHARTING. THE INDUSTRY INTRODUCED HIGHER DEFLECTION STANDARDS (THAN CODE) THAT BASICALIY REDUCED SPANS AND ULTIMATELY BOUNCINESS. AND THE MARKETING PEOPLE GAVE THESE NAMES (LIKE **3 STAR** ABOVE FOR L/480) OR **4 STAR** CHART THAT USES L/600.

***THE LONG SPANS_** ARE BOUNCIER WITH ANY JOIST OR BEAM TYPE. LONG SPANS MAY MEET CODE RESTRICTIONS BUT STILL FEEL/BE BOUNCIER THAN IS ACCEPTABLE. GUAGE THE USE. IN A FAMILY RM FLOOR IT CAN BE A PROBLEM. IN A STORAGE AREA OVER A GARAGE IT LIKELY IS NOT.

BOISE CASCADES DEFLECTION NOTE-
*& marketing attempt

Joist Depth	BCI® Joist Series	12" o.c.	16" o.c.	19.2" o.c.	24" o.c.	32" o.c.
		★★★THREE STAR★★★ Live Load deflection limited to L/480: The common industry and design community standard for residential floor joists, 33% stiffer than L/360 code minimum. However, floor performance may still be an issue in certain applications, especially with 9½" and 11⅞" deep joists without a direct-attached ceiling.				
9½"	5000 1.7	17'-1"	15'-7"	14'-9"	13'-8"	12'-0"
	6000 1.8	17'-11"	16'-5"	15'-6"	14'-5"	13'-2"
	6500 1.8	18'-5"	16'-10"	15'-11"	14'-10"	13'-6"
11⅞"	5000 1.7	20'-2"	18'-5"	17'-5"	16'-9"	13'-4"
	6000 1.8	21'-3"	19'-5"	18'-4"	17'-1"	14'-10"
	6500 1.8	21'-11"	20'-0"	18'-11"	17'-7"	14'-10"
	60 2.0	23'-3"	21'-3"	20'-1"	18'-8"	16'-4"
	90 2.0	26'-3"	23'-11"	22'-6"	20'-11"	19'-1"
14"	5000 1.7	22'-11"	21'-0"	19'-2"	17'-2"	13'-11"
	6000 1.8	24'-2"	22'-2"	20'-11"	19'-6"	15'-5"
	6500 1.8	24'-10"	22'-9"	21'-5"	20'-0"	15'-5"
	60 2.0	26'-5"	24'-2"	22'-9"	21'-3"	16'-4"
	90 2.0	29'-9"	27'-1"	25'-6"	23'-8"	19'-6"
16"	6000 1.8	26'-9"	24'-5"	23'-1"	20'-10"	15'-9"
	6500 1.8	27'-5"	25'-1"	23'-8"	21'-1"	15'-9"
	60 2.0	29'-3"	26'-8"	25'-2"	21'-10"	16'-4"
	90 2.0	32'-11"	29'-11"	28'-2"	26'-2"	19'-7"
18"	90 2.0	35'-11"	32'-8"	30'-9"	28'-7"	23'-10"
20"	90 2.0	38'-10"	35'-4"	33'-4"	30'-11"	24'-8"

DEFLECTION LIMITS EXPLAINED

***FOR ALL SPANS**_ALL BEAMS WILL DEFLECT. WE CAN PICK HOW MUCH.

***DEFLECTION SITUATION**_A ROOF RAFTER WITH ASPHALTIC SHINGLE ABOVE AND NOTHING ON THE BOTTOM OF THE RAFTER CAN (AND DOES) DEFLECT A GOOD BIT WITHOUT HARM. THE RAFTERS AND THE SHINGLE HAVE SOME 'STRETCH' THEY CAN HANDLE (L240). THE STANDARD FRAME FLOOR WITH WOOD FLOORING ABOVE AND SHEETROCK ON THE CEILING PLANE BELOW IS STILL FORGIVING TO SOME MOVEMENT WITHOUT HARM (L/360). THE BRICK VENEER SITTING OVER A WIDE GARAGE DOOR OPENING IS NOT CAPABLE OF MUCH SAGGING WITHOUT CRACKING THE MORTAR JOINTS (L/600).

***DEFLECTION CALCS**_ARE SIMPLE. L (LENGTH) /DIVIDED BY THE FACTOR = INCHES OF DEFLECTION. SO A 15' SPAN IS (15x12"=180") DIVIDED BY 240=.75". DIVIDED BY 360=.5". DIVIDED BY 480=.375". DIVIDED BY 600=.3". SO THE HIGHER THE DEFLECTION LIMIT THE LESS THE DEFLECTION.

***DEFLECTION PER CODE**_THE LIMITS BY CIRCUMSTANCE NOTED ABOVE ARE CODE LIMITS. L/240 FOR ROOF SITUATIONS, L/360 FOR FLOOR SITUATIONS, AND L/600 FOR THE MASONRY SITUATION.

***PRACTICAL THINKING**_DEFLECTION DESIGN IS FIGURED USING MAXIMUM LOAD-WHICH IN REALITY CAN BE AN INFREQUENT SITUATION. NONETHLESS IT IS SUGGESTED THAT THE MAXIMUM DEFLECTION FOR ANY CONDITION BE QUANTIFIED IN INCHES AND THE QUESTION ASKED WHETHER THIS AMOUNT OF POSSIBLE MOVEMENT WILL CAUSE ANY PROBLEMS.

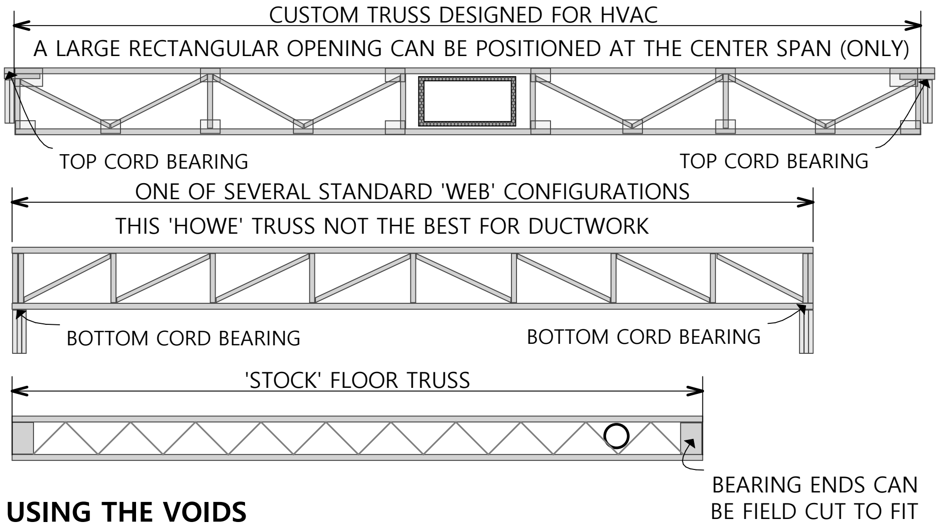
TRUSS TYPE JOISTS (AND DEAD LOADS EXPLAINED)

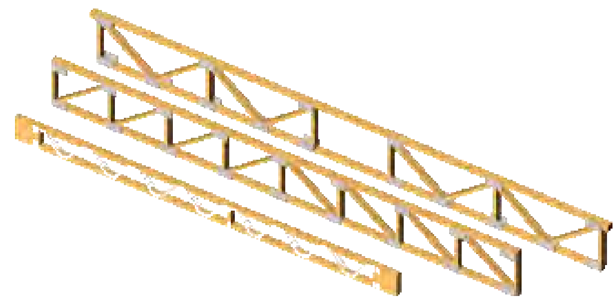
THE TRUSS PRO & CON

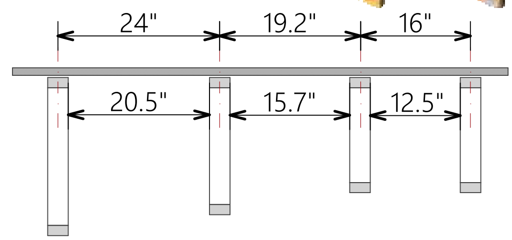
***LIGHT AND EFFICIENT**_STRUCTURALLY THE TRUSS IS VERY EFFICIENT, AND CAN BE DESIGNED TO HANDLE MOST STRUCTURAL SITUATIONS. (TO UNDERSTAND HOW FLEXIBLE THESE ARE RESEARCH TRUSS ROOF PACKAGES AND IT IS INSTANTLY DEMONSTRATED).

***BUT BULKY & BIG**_WHILE THEY ARE LIGHT AND EFFICIENT WE SOMETIMES SELECT THEM FOR LONG SPANS SITUATIONS, IN WHICH CASE THEY GET BIG AND BULKY, BECOME HARD TO HANDLE- AND CAN REQUIRE A **CRANE** FOR INSTALLATION. THINK THAT THRU. A CRANE MAKES FOR VERY FAST INSTALLATION, AND CAN BE COST EFFECTIVE IF A CREW HAS THE MANPOWER TO MAKE PACE, OR IT CAN BE EXPENSIVE IF IT HANGS AROUND ON A JOB SITE TOO LONG.

***HARD TO MASSAGE**_THERE IS AN INTERDEPENDENCE OF ALL THE TRUSS PIECES- THE TOP AND BOTTOM CORDS AND THE WEB MEMBERS. THEY CANNOT BE FIELD ALTERED WITHOUT SPECIFC ENGINEERING.







USING THE VOIDS

***WEB CONFIGURATIONS**_THERE ARE DIFERENT CONFIGURATIONS FOR THE WEBS

***VOIDS**_CERTAINLY ONE OF THE ADVANTAGES OF THE TRUSS ARE THE VOIDS AVAILABLE BETWEEN THE WEBS TO RUN MEP SYSTEMS.

***CUTS & REPAIR**_CUTTING WEBS TO INCREASE VOID AREA IS A NO NO. REPARATIONS ARE POSSIBLE WITH GLUED AND NAILED PLYWOOD ON EACH SIDE OF THE TRUSS **BUT** THIS CAN BE MADE DIFFICULT/IMPOSSIBLE IF THAT CUT WEB IS CREATING SPACE FOR DUCTWORK. AND TRUSS REPAIR MAY NEED DESIGN AND OFFICIAL SANCTION FROM AN INDEPENDENT OR MANUFACTURER'S ENGNEER.

***HVAC DESIGN FIRST**_IF TRUSSES ARE BEING SELECTED TO INTEGRATE THE HVAC DUCT SYSTEM THEN THE DUCT SYSTEM SHOULD BE LAYED OUT AND SIZED BEFORE THE TRUSS SELECTION. DUCTWORK CAN GET REAL BIG AND BULKY.

DEPTH & SPACING

***STOCK TRUSSES**_STOCK CUT OFF TRUSSES ARE USUALLY SHALLOWER WITH SHORTER SPAN CAPACITIES- AND DESIGNATED FOR 16" OR 19.2" CENTERS.

***CUSTOM TRUSSES**_ARE IN GENERAL DESIGNED FOR 19.2" OR 24" CENTERS. FEWER MEMBERS REQUIRED & USUALLY MORE COST EFFECTIVE.

STOCK TRUSS/JOISTS PROPRIETARY SPAN TABLES

***CONCEPT THE SAME**_THESE INCLUDE THE SAME VARIABLES. A 'SERIES', ASSUMED LIVE & DEAD LOADS, A DESIRED DEFLECTION LIMIT, DEPTH, AND SPACING OF MEMBERS.

DEAD LOADS SELECTED

***GENERAL**_ FLOOR DEAD LOADS MOST OFTEN SHOWN ON SPAN CHARTS ARE 10 PSF, 15 PSF OR 20 PSF. AS NOTED ACCURATE DEAD LOADS ARE PRETTY EASY TO QUANTIFY/VERIFY.

***TRUSS NOMENCLATURE**_IN TRUSS SPAN TABLE ONE MIGHT FIND 3 LOAD NUMBERS. 40-10-5. 40 IS THE LIVE LOAD, 10 IS THE FLOOR DEAD LOAD, AND 5 IS THE CEILING DEAD LOAD. COMPUTERIZED TRUSS DESIGN LIKES TO SEPARATE THE FLOOR AND CEILING LOADS AS THEY HAVE SOME (DIFFERING) EFFECT ON STRUCTURAL BEHAVIOR IN THE TRUSS. A COMMON TOTAL LOAD THEN FOUND IN TRUSS SPAN TABLES IS 55 PSF.

CUSTOM TRUSS/JOISTS PROPRIETARY SPAN TABLES

***CONTRUCTION NOTE**_A CUSTOM TRUSS MANUFACTURER **MAY** OFFER TRUSS CONSTRUCTION WITH 2X3 OR 2X4 CORDS AND WEBS, OR MAY OFFER DIFFERENT/BETTER GRADES OF LUMBER WHICH WILL EFFECT SPAN LIMITS.

***MAKE EM CUSTOM**_USUALLY A CUSTOM TRUSS MANUFACTURER WILL TAKE ARCHITECTURAL PLANS AND CREATE A TRUSS/STRUCTURAL LAYOUT FOR APPROVAL AND THEIR OWN MANUFACTURING. THIS IS WHERE INTEGRATING HVAC REQUIREMENTS AND ALLOWING FOR A STRUCTURAL 'CONDITION' CAN TAKE PLACE. ONCE THE TRUSS IS BUILT IT IS TOO LATE.

***AVAILABILITY**_TRUSS MANUFACTURERS ARE SCATTERED ABOUT. ONE NEEDS TO CHECK LOCATION AND DELIVERY COSTS EARLY AS THIS COULD THROW THE COST FORMULA OFF.

SPACE JOIST MANUFACTURER-
*does construct with metal webs as suggested in the 3d image above
*other manufacturers use wood webs
*the cut off ends also may vary- but offer that flexibleity of adjusting to fit.
*custom trusses do not allow any field adjustment

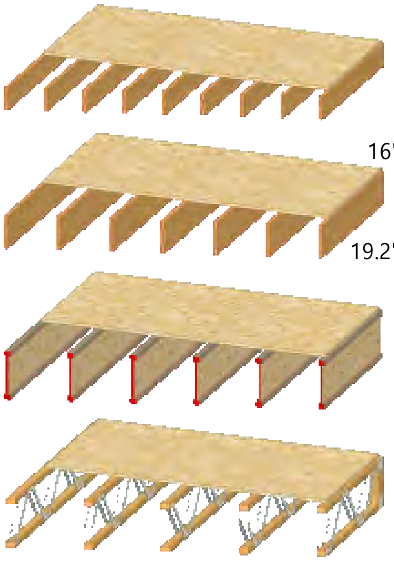
Maximum Spans: 40-10-5 3[illegible]0 Series

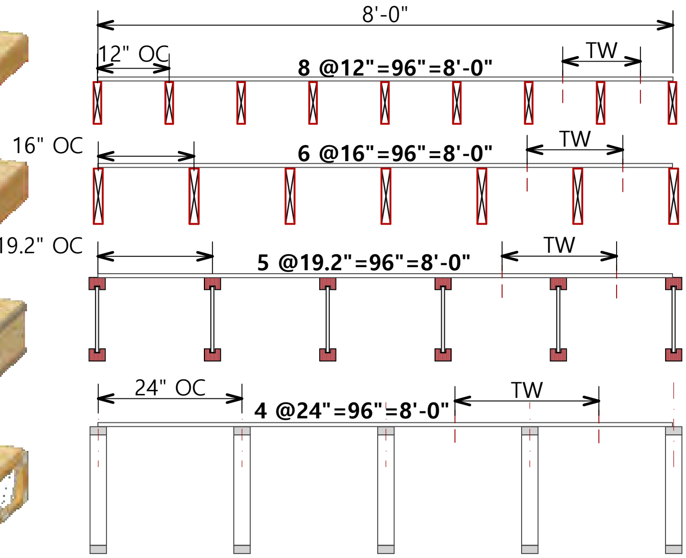
Depth	Deflection	24" O.C.	19.2" O.C.	16" O.C.	12" O.C.
9¼"	L/480	12'9"	13'10"	14'8"	16'1"
	L/360	14'1"	15'3"	16'1"	17'11"
11¼"	L/480	15'3"	16'7"	17'8"	19'6"
	L/360	16'0"	18'4"	19'7"	21'6"
11 7/8"	L/480	16'0"	17'4"	18'6"	20'4"
	L/360	16'0"	19'2"	20'5"	22'6"
14"	L/480	18'3"	19'9"	20'11"	23'3"
	L/360	18'6"	20'8"	23'3"	25'7"
16"	L/480	18'6"	22'2"	23'8"	26'2"
	L/360	18'6"	22'11"	26'2"	28'9"

40 PSF Live Load
55 PSF Total Load

Center Spacing	Deflection Limit	Truss Depth 12"	14"	16"	18"	20"	22"
16" o.c.	L/360	22'2"	24'11"	26'10"	28'8"	30'4"	31'11"
	L/480	20'2"	22'7"	24'11"	27'2"	29'4"	31'5"
19.2" o.c.	L/360	20'9"	22'8"	24'4"	26'0"	27'6"	29'0"
	L/480	18'11"	21'3"	23'6"	25'7"	27'6"	29'0"
24" o.c.	L/360	18'5"	20'1"	21'7"	23'1"	24'5"	25'9"
	L/480	17'7"	19'9"	21'7"	23'1"	24'5"	25'9"

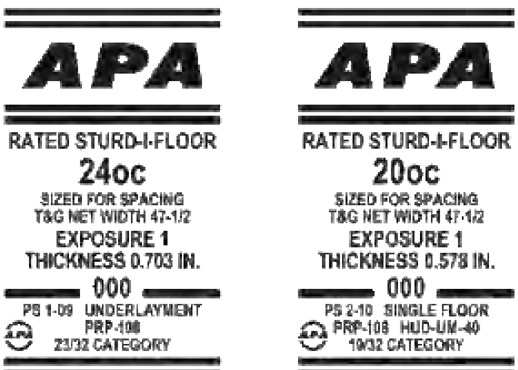
FRAME FLOORS c5.7
FRAMING CENTERS AND SHEATHING





CENTERS

***ON CENTER**_CENTERLINE TO CENTERLINE OR 'ON CENTER' ABBREVIATED AS O.C. IS THE LANGUAGE.
***INCREMENTS OF 8'**_CENTER SELECTIONS ARE IN SYNC WITH THE STANDARD LENGTH OF SHEATHING WHICH IS 8'.
STANDARD OF 16"_TRADITIONALLY THE MOST COMMON CENTERING WELL SUITED TO DIMENSIONAL LUMBER. ENGINEERED JOISTS AND TRUSSES GENERALLY OFFER WIDE CENTERS AS THEIR STRUCTURAL CAPACITIES ARE GREATER.
***TW**_THE TRIBUTARY (LOAD) WIDTH FOR A JOISTS IS THE SAME AS ITS CENTER. IF A LIVE AND DEAD LOAD TOTAL 50 PSF THEN AN 8" CENTER/TW IS 50 X .66 OR 36 POUNDS PER LINEAL FT. IF THE CENTER/TW IS 24" THEN THE LOAD IS 50 X 2 OR 100 POUNDS PER LINEAL FT (PLF).



3 NOT UNTYPICAL DEAD LOAD ASSEMBLIES

*LOAD CHARTS FOR MATERIALS ARE EASILY FOUND AND DO NOT ALWAYS CORRESPOND EXACTLY.
*A SAFE AND SMART APPROACH IS TO CREATE A QUICK BUT EDUCATED ESTIMATE AND ROUND UP.
*THE CLEAR CONCLUSION FROM THESE SAMPLES IS WHEN TILE/MASONRY PRODUCTS ARE INCLUDED. BOTH DEAD WEIGHT GOES UP AND THE DESIRE TO KEEP FLOOR STIFFER.

DEAD LOAD 18.8 PSF	DEAD LOAD 10.0 PSF	DEAD LOAD 6.4 PSF
*1/2" GWB CEILING_2.2 PSF	*1/2" GWB CEILING_2.2 PSF	*DUCTWORK (AVERAGE)_.5 PSF
*8" SOUND BATTS_.8 PSF	*2X10@19.2_2.5 PSF	*12" ENGINEERED JSTS@24_1.6 PSF
*2X10@16_2.9 PSF	*3/4" FLOOR SHEATHING_2.3 PSF	*3/4" FLOOR SHEATHING_2.3 PSF
*3/4" FLOOR SHEATHING_2.3 PSF	*3/4" OAK HARDWOOD_3.0 PSF	*CARPET+PAD FLOORING_2.0 PSF
*7/16" CEMENT BOARD_3.0 PSF		
*3/8" CERAMC TILE_4.7 PSF		

SHEATHING AND SHEATHING RATINGS

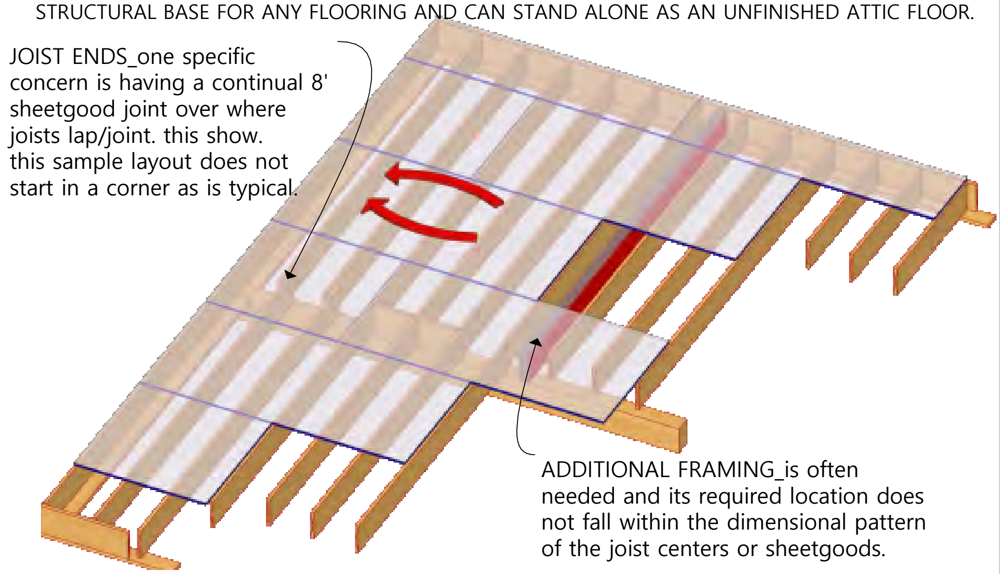
*THESE 4X8 SHEETS ARE SOMETIMES REFERRED TO AS SHEETGOODS, OR PLYWOOD. PLYWOOD IS ACTUALLY A ENTIRELY DIFFERENT MANUFACTURE AND IS AVAILABLE AND USED. BUT FOR FLOORING THIS OSB SHEETGOODS IS SIMPLY A MORE COST EFFECTIVE AND STABLE SOLUTION. ALL SHEETGOODS COME WITH A RATING STAMP ON EVERY SHEET. PLEASE REFER TO THE APA (AMERICAN PLYWOOD ASSOCIATION) WEB SITE FOR COMPLETE DATA ON ALL MANUFACTURED SHEETGOODS AND THE ENTIRE RATING SYSTEM.

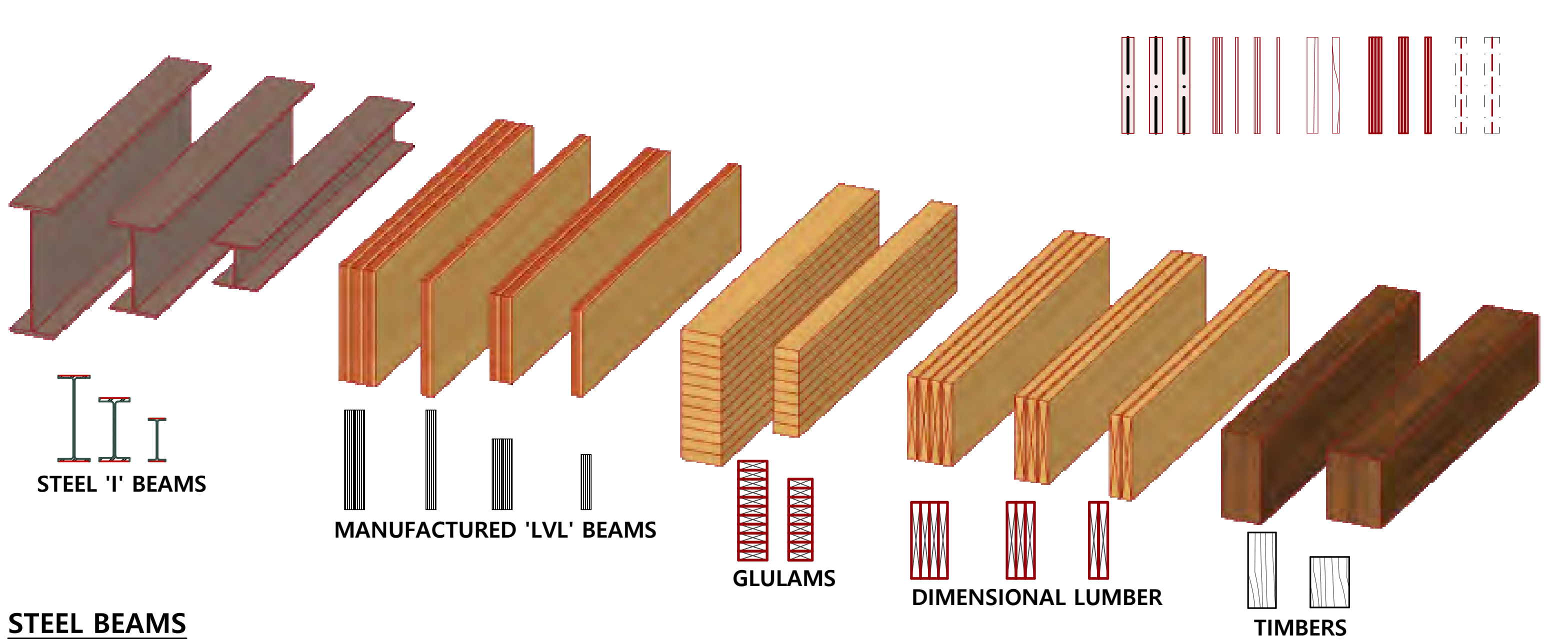
LAYOUT AND SPACING

***SPACING**_FRAMING AND SUBSEQUENT SHEATHING MUST BE LAYED OUT FOR SIMPLICITY, ECONOMY AND STRUCTURE. THE FRAMING CENTERS NEED TO BE CONSISTENT AND FOLLOW THE FASTENING RULES OF THE 4X8 SHEETS. ONE UNIVERSAL RULE IS THE 8' LENGTH SHOULD BE PERPENDICULAR TO THE JOISTS. SEE CENTERS AND THE 8' DIMENSION ABOVE. AND THAT 8' LENGTH MUST BE STAGGERED IN LAYOUT.
***STARTING**_STARTING IN A (BEST) CORNER IS TYPICAL. THIS SAMPLE LAYOUT IS DIFFERENT ON PURPOSE.
***SHEATHING NOTES**_THE 3/4" (23/32" ACTUAL) THICKNESS GIVES A FAIRLY SUBSTANTIAL FEEL TO A FLOOR, AND IS NEEDED TO PERMIT THE TOUNGE AND GROOVE EDGE FORMAT THAT IS CRITICAL TO UNIFORM STABILITY. THIS FLOOR SHEATHING, AS ALL STICK FRAME SHEATHING (FLOOR, WALLS, ROOF) HOLD ALL THESE STICKS SQUARE AND TORSIONALLY RIGID. SHEATHING IS THE 'MAGIC GLUE' IN FRAME CONSRUCTION.

SHEATHING ON FLOOR FRAMING

*VIRTUALLY ALL FLOOR FRAMING GETS COVERED WITH 4X8 SHEETS OF OSB (ORIENTED STRAND BOARD) WHICH IS THE TERM/DECRIPTION FOR SHEETS COMPOSED OF THE MANY WOOD CHIPS. IT IS A GREAT PRODUCT FROM A COST, STRUCTURE, AND ENVIRONMENTAL STANDPOINT. AN ALMOST UNIVERSAL SELECTION FOR FLOORING IS THE 3/4" TOUNGUE AND GROOVE BOARD AS IT IS A GOOD STRUCTURAL BASE FOR ANY FLOORING AND CAN STAND ALONE AS AN UNFINISHED ATTIC FLOOR.





STEEL BEAMS

***SHAPE & SIZES_** THERE ARE A FEW OFFICIAL DESINGATIONS FOR STEEL BEAMS THAT RESEMBLE AN 'I' SHAPE. THEY ALL SHARE THAT GREAT EFFICIENCY OF SHAPE AS A FUNTION OF THE FLANGES AND DISTANCE FROM THE NEUTRAL AXIS. THE GREATEST SELECTION OF SIZES & SHAPES ARE IN THE WIDE FLANGE SHAPE/DESIGNATION (W). W(NOMINAL HEIGHT)x(WEIGHT PER FT) IS THE STANDARD NOMENTCLATURE. W4X13 IS THE SMALLEST AT 4" HIGH AND 13 LBS PER LIN FT. W44X335 IS THE LARGEST AT 44" HIGH AND 335 LBS PER LIN FT. THE MODEST STRUCTURAL REQUIREMENTS IN RESIDENTIAL CONSTRUCTION SUGGEST 8" TO 18" HEIGHTS, AND WEIGHTS FROM 10 LBS PER FT TO MAYBE 40 LBS PER FT. EXCEPTIONS EXIST OBVIOUSLY.

***CONSTRUCTION_**MANUFACTURED IN LONG (TRACTOR TRAILER) LENGTHS. LOCAL DISTRIBUTORS WILL TYPICALLY CUT PER ORDER TO SIZE.

***EFFICIENCY_**STRUCTURALLY THE MOST EFFICIENT. (NOT CARBON FRIENDLY)

***EASE OF USE_**WITH EXPERIENCE THESE ARE TOLERABLY EASY. SOME DISTRIBUTORS HAVE INSTALL PEOPLE THAT CAN CUT/DRILL/BOLT ETC ON SITE. IF FRAMERS ARE DOING THE INSTALL THEN IT IS BEST TO KEEP IT SIMPLE.

ENGINEERED (LVL) BEAMS

***CONSTRUCTION_**THE LVL (LAMINATED VENEER LUMBER) IS ONE OF A FEW ENGINEERED MEMBER TECHNOLOGIES, AND BEST AND MOST COMMON IN BEAM/SPAN CONDITIONS. IT IS A BUILT UP 'PLY' CONSTRUCTION WITH ALL WOOD FIBER STRANDS RUNNING IN THE SAME HORIZONTAL DIRECTION GIVING IT A HIGH STRUCTURAL (FIBER BASED) EFFICIENCY.

***SHAPE & SIZES_**RECTANGULAR. THE STANDARD WIDTH IS 1 3/4". 2 MEMBERS= 3.5", SAME AS A STUD. DEPTH FROM 7 1/4 (MATCHING A 2X8) UP TO 24" (ALTHOUGH NOT AVAILABLE WITH ALL MANUFACTURERS). UP TO 3 UNITS WIDE IS COMMON RESULTING IN THE POSSIBILITY OF A 5.25" W X 24" D BEAM THAT CAN HANDLE SOME SERIOUS LOAD AND CAN BE HANDLED/INSTALLED 1 UNIT AT A TIME WITHOUT MECHANICAL ASSISTANCE. THESE ARE STRONG AND FLEXIBLE. THEY HAVE LARGELY SUPPLANTED STEEL FLITCH PLATES AND PLYWOOD BOX BEAMS.

***EASE OF USE_**VERY. JUST AS FLEXIBLE AS ANY LUMBER. THEY ARE MANUFACTURED AND INHERENTLY STRAIGHT. BUT IF LEFT OUTSIDE IN VARYING WEATHER OR AWKWARD STORAGE POSITIONING THEY WILL BEND & BOW-

GLULAMS (GLUED LAMINATED LUMBER)

***SHAPE & SIZES_**RECTANGULAR SHAPES. 3"Wx5.5"H UP TO 10.5"Wx50"H. 2X4 AND 2X6 WIDTHS

***CONSTRUCTION_**STACKED AND GLUED 2X DIMENSIONAL LUMBER. LUMBER GRADES ARE SPECIFIED, SO CAN BE KNOTTY OR CLEAR. THE GLULAMS ARE UNIQUE IN THAT THEY CAN BE GLUED UP (PREFABRICATED) INTO CURVED SHAPES.

***EFFICIENCY_**RECTANGULAR SHAPE HAS SOME WASTED BULK. BECAUSE THEY ARE GLUED UP OF CONTOLLED QUALITY MEMBERS (PIECES). THEY ARE MORE PREDICTABLE, STABLE AND CONSISTENT THAN LARGE SINGLE PIECE TIMBERS.

***EASE OF USE_**JUST AS FLEXIBLE AS ANY LUMBER IN TERMS OF CUTTING/FASTENING. SIZE AND WEIGHT ARE AS NEEDED/SPECIFIED, SO LARGER MEMBERS MAY/WILL REQUIRE MECHANICAL HOISTING OF SOME KIND.

***AESTHETICS_**USUALLY SPECIFIED WHEN INTENDED TO BE EXPOSED. THERE IS AN 'ARCHITECTURAL' GRADE WHEN A CLEAR APPEARANCE IS DESIRED.2 THEY LOOK GOOD. THEY LOOK GREAT WHEN CURVED. IF A BEAM CANNOT BE SEEN- LVL BEAMS ARE MORE COST EFFECTIVE.

MULTIPLE PLYS OF DIMENSIONAL LUMBER-

***SHAPE & SIZES_**RECTANGULAR SHAPES. 2X6, 2X8, 2X10, 2X12. SOME (TIMBER) REGIONS MAY OFFER DEEPER MEMBERS.

***CONSTRUCTION_**MILLED FROM TREES. BY SPECIES AND GRADE. MUST BE 'DRY' BEFORE INSTALLATION.

***EFFICIENCY_**RECTANGULAR SHAPE HAS WASTED BULK. EVEN IN MULTIPLES THESE HAVE SPAN/DEFLECTION LIMITATIONS THAT ARE RESTRICTIVE. USEFUL AS WINDOW AN DOOR HEADERS BECAUSE OF THEIR SHORTER SPANS, AND AS ATTIC & CEILING BEAMS WHEN LOADING IS LESS.

***EASE OF USE_**VERY FLEXIBLE.

***AESTHETICS_**USUALLY COVERED OR BURIED. BUT CERTAINLY CAN BE EXPOSED LIKE TIMBERS WITH CAREFUL INSTALLATION & FASTENING.

TIMBERS

***SHAPE & SIZES_**A VARIETY OF RECTANGULAR SHAPES. THERE IS AN ART+SCIENCE MILLING THESE FROM LOGS. FREQUENTLY LOCALLY SOURCED.

***CONSTRUCTION_**MILLED FROM TREES. BY SPECIES AND GRADE. OR RECLAIMED FROM OLD ABANDONED STRUCTURES. MUST BE 'DRY' BEFORE INSTALLATION.

***EFFICIENCY_**NOT VERY BY COMPARISON IN TERMS OF SPANS AND DEFLECTION. BUT NOTE THE 'BULK' (IF YOU WILL) HAS SOME STRUCTURAL ADVANTAGES IN BEARING/SHEAR/MOMENT/NOTCHING.

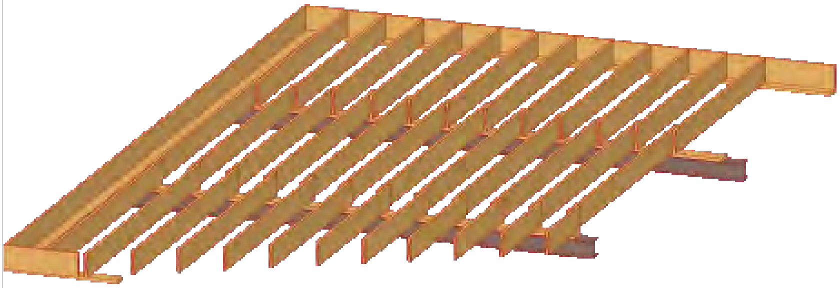
***EASE OF USE_**JUST AS FLEXIBLE AS ANY LUMBER IN TERMS OF CUTTING/FASTENING. CAN BE HEAVY.

***AESTHETICS_**USUALLY SPECIFIED WHEN INTENDED TO BE EXPOSED. THEY ALSO LOOK GOOD. THEY LOOK BEST WHEN THE EXPOSED BEAMS OR POST AND BEAM DESIGN HAS BEEN WELL THOUGHT OUT.

JOISTS AND BEAMS IN A FLOOR SYSTEM

JOISTS SYSTEMS HAVE DIFFERENT INHERENT CHARCTERISTICS

***THE JOIST (AND BEAM) DECISION_**BELOW ILLUSTRATES JOISTS IN PLACE PERFORMING ON THEIR OWN & WITHOUT THE COMPLICATIONS OF LOADING FROM ABOVE, OR SUPPORTS REQUIRED BELOW. SO THESE VARIOUS JOIST SYSTEMS ARE BEING PRESENTED IN SOMEWHAT IDEALIZED CIRCUMSTANCES. NONETHELESS DIGESTING THE PRIMARY ASSETS OF A GIVEN SYSTEM IS A STARTING PLACE. THE SUPPORTING BEAM TYPE SELECTION CERTAINLY CAN BE INFLUENCED BY THE JOIST TYPE AND SPAN. BEAM TYPES SHOWN ARE IN SINK WITH THE JOIST THEY SUPPORT.



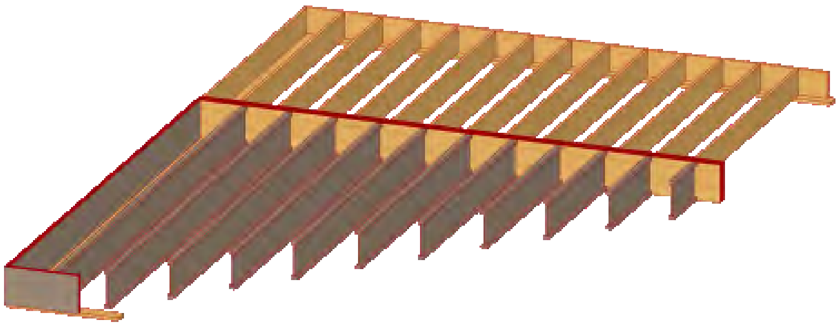
DIMENSIONAL LUMBER-LIMITED SPANS

***GENERAL_(**c5.4) NOTES THE SPAN CAPACITIES OF TYPICAL 2X MEMBERS IN A FLOOR APPLICATION.

***THIS ILLUSTRATION_**IS SUGGESTING 3 EQUAL, SHORTER SPANS.

***FLEXIBILITY_**DIMENSIONAL LUMBER IS FLEXIBLE. FIELD ADJUSTMENTS ARE MANAGEABLE.

***BEAM SUPPORTS_** DROP BEAMS ARE SHOWN. THEY SIT BELOW THE JOISTS. WOOD TYPE BEAMS OR STEEL ARE THE CHOICES.



COMPOSITE FRAMING

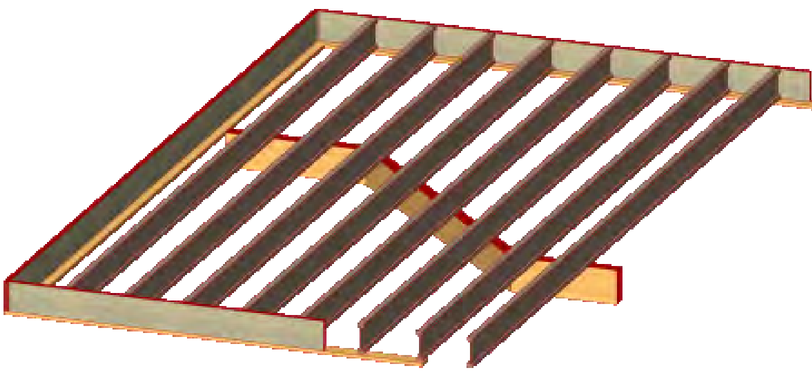
***GENERAL_**THERE CAN BE INSTANCES WHERE MUCH/MOST FRAMING IS MANAGED WITH ONE (DEPTH) OF DIMENSIONAL LUMBER BUT ONE CONDITION REQUIRES A GREATER SPAN.

***DIMENSIONAL LUMBER_**DEPTH AS REQUIRED TO MEET THE SHORTER SPAN CONDITIONS.

***ENGINEERED JOISTS_**DEPTH (OR SERIES) AS REQUIRED TO MEET THE LONGER SPAN CONDITION.

***FLUSH LVL BEAM_**AS SHOWN FLUSH WITH THE ENG JSTS. NOTE LVL'S AND ENJ JSTS PURPOSEFULLY HAVE MATCHING HTS.

***FOUNDATION PREP_**DIFFERING JOIST DEPTHS HAVE CONSEQUENCES AT THE PERIMETER SUPPORT WALLS AND NEED TO BE PLANNED FOR.

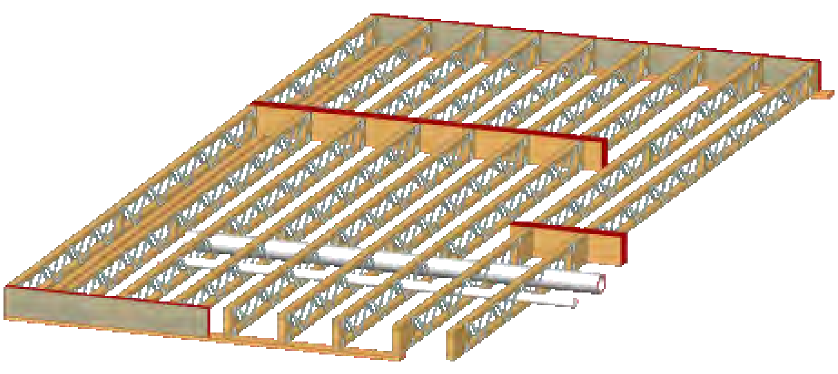


FULL SPAN ENGINEERED JOISTS

***GENERAL_**ENGINEERED JOISTS ARE EFFICIENT, LIGHT WEIGHT, AND AVAILABLE IN LONG LENGTHS-UP TO 40'. THIS ALLOWS A SINGLE MEMBER TO BE PLACED OVER MULTIPLE SUPPORTS. PRETTY FAST AND EFFICIENT.

***MAXIMUM SPAN_**IN A CASE AS ILLUSTRATED THE JOIST SELECION WOULD START WITH RECOGNIZING THE MAXIMUM SPAN AND SELECTING A MEMBER ACCORDINGLY.

***CONTINUOUS SPANS_**WHEN A MEMBER PASSES OVER 1 OR MORE SUPPORTS ITS STRUCTURAL BEHAVIOR DOES CHANGE. SO OTHER 'CONDITIONS' COME INTO PLAY THAT SHOULD BE CHECKED. MOST SUPPLY VENDORS FOR ENGINEERED PRODUCTS HAVE TRAINED PEOPLE AND PROPRIETY STRUCTURAL SOFTWARE TO HELP WITH SPECIFIC SELECTIONS.

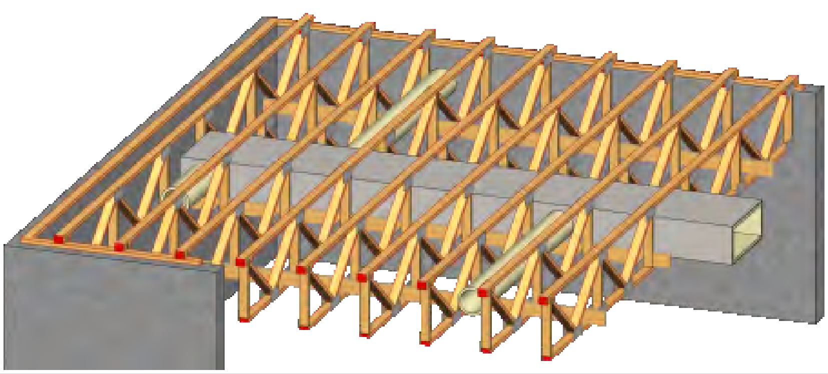


FIELD FITTING TRUSSES

***GENERAL_**THESE PREMANUFACTURED WEBED TRUSS JOISTS HAVE AS MUCH AS 12" ON EACH END THAT CAN BE FIELD TRIMMED. THEY THERFORE CAN BE ORDERED TO A SLIGHTLY OVERSIZED LENGTH AND FIELD CUT TO FIT.

***BEARING_**THESE ARE NOT TOP BEARING - MEANING THEY CAN EITHER SIT ON A DROP BEAM OR PERIMETER WALL AND PLATE (AS SHOWN) OR BE FLUSH MOUNTED TO ANY CENTER SUPPORT BEAMS (AS SHOWN) USING APPROPRIATE HANGERS.

***THE OPENINGS_**MANUFACTURERS WILL CLEARLY SHOW IN THEIR SPEC SHEETS THE MAXIMUM OPENING SIZES THAT EXIST IN THE WEB SPACE. ALL ELECTRICAL, MOST PLUMBING, BUT ONLY SOME SMALLER DIAMETER HAVAC RUNS CAN COMFORTABLY TAKE ADVANTAGE OF THESE OPENINGS. HVAC PLANNING REQUIRED.



TAKING ADVANTAGE OF THE BIG TRUSS

***GENERAL**THIS ILLUSTRATION SHOWS A TOP CORD BEARING FULL SPAN TRUSS WITH A LARGER CENTER RECTANGULAR WEB OPENING

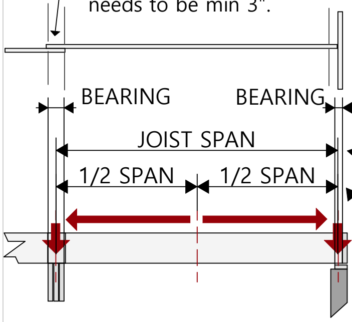
***TOP CORD BEARING_**ALLOWS A HIGHER FOUNDATION WALL AND A PROTECTED HIGHER EXTERIOR GRADE.

***THE FULL SPAN_**THIS CUSTOM FLOOR TRUSS MAY BE 20" OR 24" DEEP AND CAPABLE OF LARGER SPANS. IN SOME INSTANCES THIS MAY ELIMINATE THE NEED FOR BEAMS & POSTS BELOW

***CENTER OPENING_**WONDERFUL CONCEPT-BUT HVAC PLANNING REQUIRED, AND TRUSSES MUST BE FREE OF ANY SUPERIMPOSED LOADING THAT REQUIRE SUPPLEMENTAL STRUCTURE. THIS IS A BIG DEAL AND CAN BE VERY RESTICTIVE.

THE CORE LOAD DISTRIBUTION IDEA

THE LAP
*With joists sitting on top of a 'drop' beam the lap needs to be min 3".



BEARING_the min code compliant bearing is $1^{1/2}$". That is $1^{1/2}$ lineal inches at the end of the joist. Sometimes this needs checking based on the joist type and situation.

SPAN_technically from centerline of bearing to centerline of bearing. It is common and no real harm to round these span lengths up.

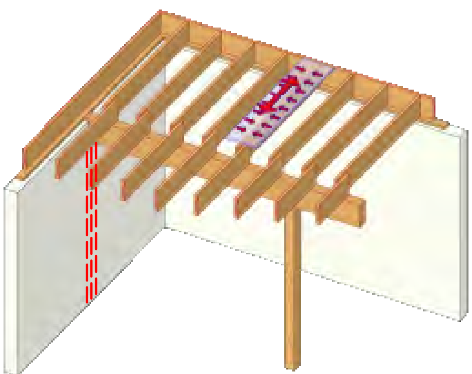
1/2 SPAN LOAD DISTRIBUTION_is the rule that governs where loads get distrubuted. The term is tributary width. TW is the acronym.

FROM ROOF DOWN

***TW**_THIS SIMPLE 1/2 SPAN LOAD DISTRIBUTION-THE TRIBUTARY WIDTH OR TW- IS THE NUCLEUS OF LOAD TRACKING. IN CONCEPT IT STARTS AT THE ROOF-THE UPPERMOST LOADS- AND GETS TRACKED DOWN THRU A CONSTRUCTION ULTIMATELY TO THE FOOTING. THAT TERM IS LOAD TRACKING.
SIMPLE STACKED CONSTRUCTION_(c5.11) ILLUSTRATES A STACKED/SYMMETRICALLY DESIGNED CONSTRUCTION WHEREIN LOAD TRACKING IS QUITE STRAIGHTFORWARD.
OTHER COMPLEX CONSTRUCTION_(C5.12) ILLUSTATES A MORE COMPLEX CONSTRUCTION GEOMETRY AND HOW LOAD TRACKING CAN GET A LITTLE DIZZYING, AND BEYOND WHAT MOST FOLKS CAN CARRY IN THEIR HEADS. EVEN SO THAT SIMPLE CORE PRINCIPLE OF HALF SPAN DISTRIBUTIUON IS VALUABLE WHEN ON SITE AND GETTING A FEEL FOR WHERE THE LOADS ARE GOING.

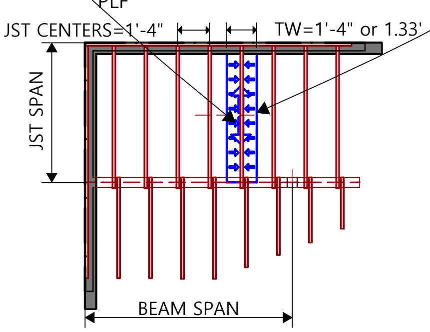
LOAD ON THE JOIST

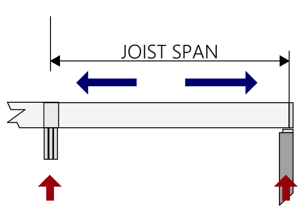
BASED ON TRUBUTARY WIDTH
OF THE JOIST CENTERS.
A 'UNIFORM' LOAD IN PLF



THE JOIST DISTRIBUTION
*Half the load to the wall, half the load to the beam. Loads in plf.

THE JOIST TRIBUTARY WIDTH
*Half the distance between joist on each side. Load in PLF



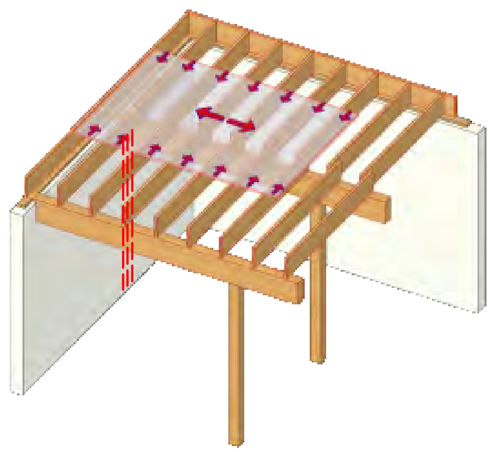


CALCULATION

*JOIST CALCULATION IS UNIT PSF LOAD, CENTERS,AND JST SPAN PER SPAN TABLES.
*POINT LOAD AT THE WALL AND THE BEAM IS THE SAME-UNIT PSF LOAD x 1/2 THE SPAN.

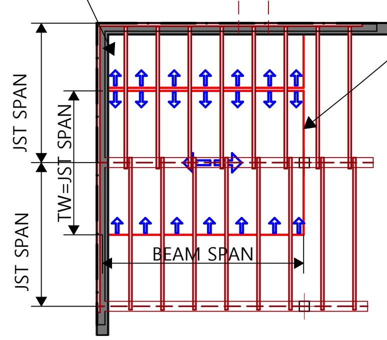
LOAD ON THE BEAM

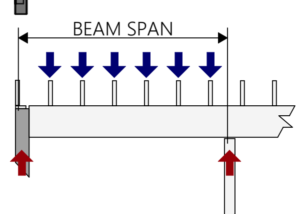
BASED ON TRUBUTARY WIDTH
OF THE JOIST SPANS
A 'UNIFORM' LOAD IN PLF



THE WALL LOAD TRIBUTARY WIDTH
*Half the joist span to the wall. Load in PLF

THE BEAM TRIBUTARY WIDTH
*Half the joist span on each side of the beam. Load in PLF



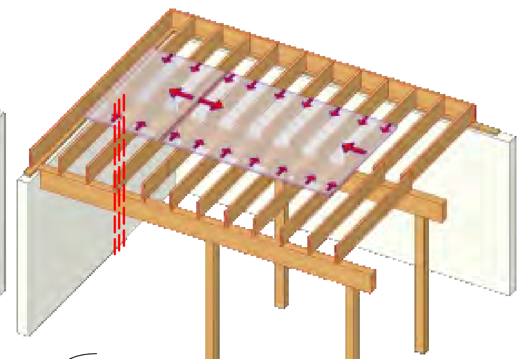


CALCULATION

*UNIFORM LOAD ON THE BEAM IS TW OF THE JSTS x UNIT PSF LOAD = BEAM LOAD IN PLF.

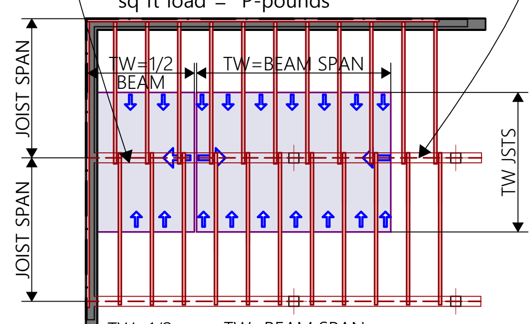
LOAD ON THE POST(S)

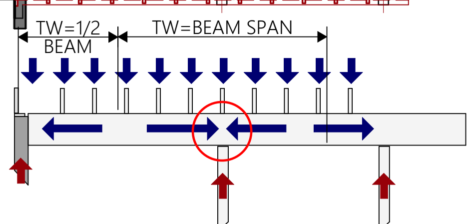
BASED ON TRIBUTARY AREA
OF JOIST SPANS AND BEAM SPANS-
A 'CONCENTRATED' OR 'POINT' LOAD IN P-pounds



IN WALL SUPPORT TRIBUTARY AREA
*Half the joist span each side of the beam and half the beam span from wall to post. Area x pounds per square ft = total P-pounds

THE POST TRIBUTARY AREA
*Half the joist span each side of the beam and half the beam span each side of the post. Area x pounds per sq ft load = P-pounds





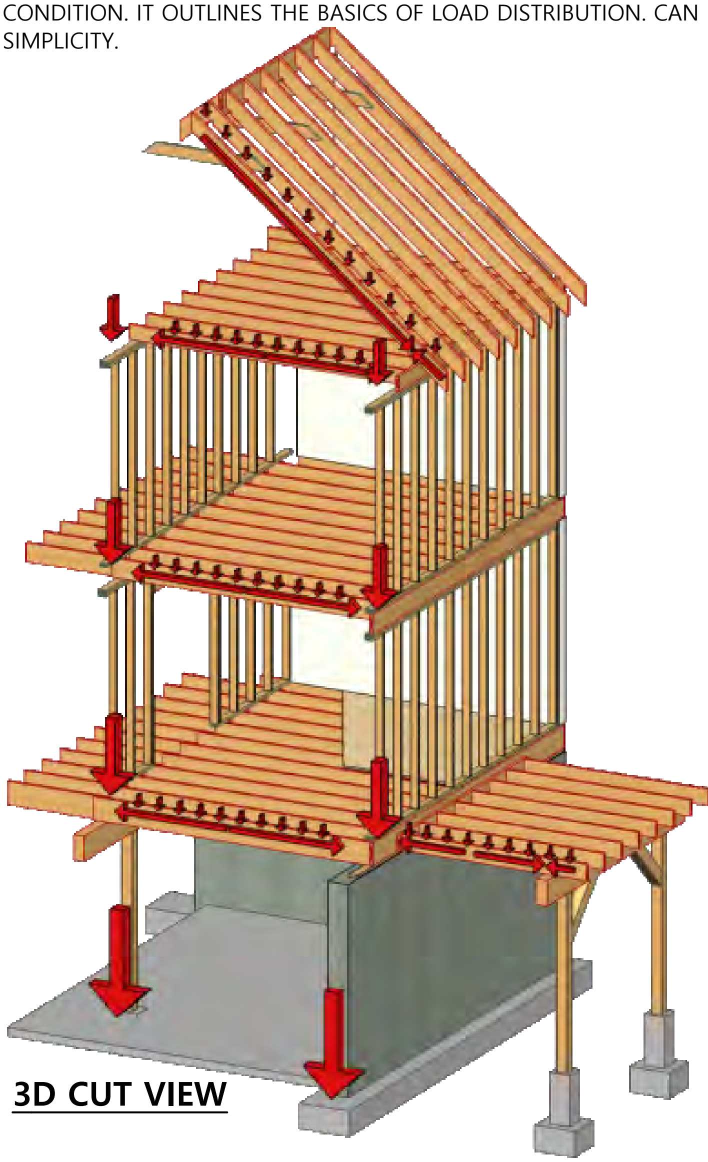
CALCULATION

*LOAD AT POST = AREA X TL PER SQ FT
*LOAD AT WALL = AREA X TL PER SQ FT

TRIBUTORY LOADING IN STACKED CONSTRUCTION

STACKED CONSTRUCTION-THE MOST SIMPLE CONDITION

***TYPICAL FRAMING CONDITIONS**_THE ILLUSTRATION BELOW REPRESENTS THE MOST STRAIGHTFORWARD AND ECONOMICAL STRUCTURAL FRAMING CONDITION. IT OUTLINES THE BASICS OF LOAD DISTRIBUTION. CAN BE TOUGH TO CREATE EFFECTIVE FLOOR PLAN DESIGNS THAT CONFORM TO THIS SIMPLICITY.



3D CUT VIEW

ROOF (c7)

***ROOF LIVE LOADS**_FROM 20 PSF TO 100 PSF BASED ON REGION/SNOW LOAD
***ROOF DEAD LOADS**_10 PSF TYPICAL, 20 PSF IF HEAVY ROOFING SELECTED.
***DISTRIBUTION**_LOAD DISTRIBUTION FOR RAFTERS WILL BE SUMMARIZED IN (c7). FOR THIS EXERCISE IT CAN BE ASSUMED THAT THE FULL RAFTER SPAN, MEASURED HORIZONTALLY. IS BEING LOADED ON THE OUTSIDE BEARING WALL.

ATTIC LEVEL

***CEILING OR FLOOR?** _ATTIC JOISTS MAY BE SERVING THE FUNCTION OF A CEILING (ONLY), OR AS A STORAGE (ONLY) FLOOR, OR AS A FUTURE SPACE OR AS HABITABLE SPACE (c5).
***LIVE LOADING**_CODE WILL STIPULATE ALLOWABLE LIVE LOADS OF 10 PSF FOR NO STORAGE, 20 PSF FOR LIGHT STORAGE. IF CODE COMPLIANT STAIRS ARE INSTALLED THEN THE ATTIC (JOISTS) WILL NEED TO CONSIDER LIVE LOADS OF 30 PSF FOR SLEEPING AREAS AND 40 PSF FOR ALL OTHER USES.
***DEAD LOADS**_10 PSF IS TYPICAL FOR NON HABITABLE ATTIC USES. HABITABLE SPACE FLOOR ASSEMBLIES MAY BE MORE.
***DISTRIBUTION**_1/2 OF SPAN LOAD IS DISTRIBUTED TO THE OUTSIDE WALL AND 1/2 DISTRIBUTED TO THE CENTER WALL.

UPPER FLOOR LEVEL

***LIVE LOADING**_ LIVE LOADS OF 30 PSF FOR SLEEPING AREAS AND 40 PSF FOR ALL OTHER LIVING SPACES
***DEAD LOADS**_10 PSF IS TYPICAL FOR CARPETED AREAS. BATHROOMS WITH TILE FLOORS, PLUMBING FIXTURES, AND (FULL) BATHTUBS WILL MERIT HIGHER DEAD LOAD ALLOWANCES.
***DISTRIBUTION**_1/2 OF SPAN LOAD IS DISTRIBUTED TO THE OUTSIDE WALL AND 1/2 DISTRIBUTED TO THE CENTER WALL.

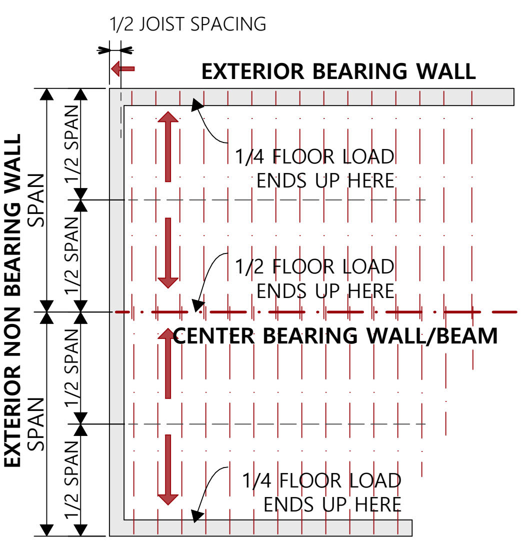
MAIN FLOOR LEVEL

***LIVE LOADING**_ LIVE LOADS OF 30 PSF FOR SLEEPING AREAS AND 40 PSF FOR ALL OTHER LIVING SPACES
***DEAD LOADS**_10 PSF -20 PSF BASED ON SPECIFIC ASSEMBLY CONSTRUCTION
***DISTRIBUTION**_1/2 OF SPAN LOAD IS DISTRIBUTED TO THE OUTSIDE WALL AND 1/2 DISTRIBUTED TO THE CENTER BEAM.

LOAD TRACKING COMMENT

***EXTERIOR WALL**_ROOF LOAD/LESS FLOOR LOADING/FOUNDATION WALL LOADING/ CONTINUOUS LOAD AT CONTINUOUS FOOTING.
***INTERIOR**_NO ROOF LOADING/MORE FLOOR LOADING/NO FOUNDATION WALL LOADING. BASEMENT BEAM DISTRIBUTION RESULTS IN SOME PRETTY BIG LOADS AT THOSE POST FOOTINGS.

PLAN



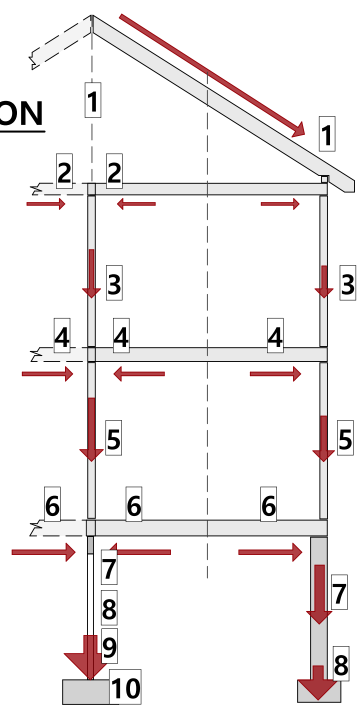
EXTERIOR BEARING WALL

1*ROOF LOAD_1/2 SPAN X LL & DL
2*CEIL JST LOAD_1/2 SPAN X LL & DL
3*UPPER FLOOR FRAME WALL LOAD_HT X DL (WT PER FT)
4*UPPER FLOOR LOAD_1/2 SPAN X LL & DL
5*MAIN FLOOR FRAME WALL LOAD_HT X DL (WT PER FT)
6*MAIN FLOOR LOAD_1/2 SPAN X LL & DL
7*FOUNDATION WALL LOAD_HT X DL (WT PER FT)
8*FOOTING LOAD_WT PER LIN FT
***TOTAL LOAD AT GRADE**_WT PER LIN FT÷FOOTING WIDTH

THE CENTER WALL & BEAM

1*ROOF LOAD_NONE
2*CEIL JST LOAD_1/2 SPAN + 1/2 SPAN X LL & DL
3*UPPER FLOOR FRAME WALL LOAD_HT X DL (WT PER FT)
4*UPPER FLOOR LOAD_1/2 SPAN + 1/2 SPAN X LL & DL
5*MAIN FLOOR FRAME WALL LOAD_HT X DL (WT PER FT)
6*MAIN FLOOR LOAD_1/2 SPAN + 1/2 SPAN X LL & DL
7*BEAM LOAD _HT X DL (WT PER FT)
8*BEAM DISTRIBUTION TO POSTS_1/2 SPAN + 1/2 SPAN X PLF
9*WEIGHT OF POST_HT X DL (WT PER FT)
10*FOOTING DEAD LOAD_WT PER CUBIC FT
***TOTAL LOAD AT GRADE**_ SUMMARY IN TOTAL LBS

SECTION

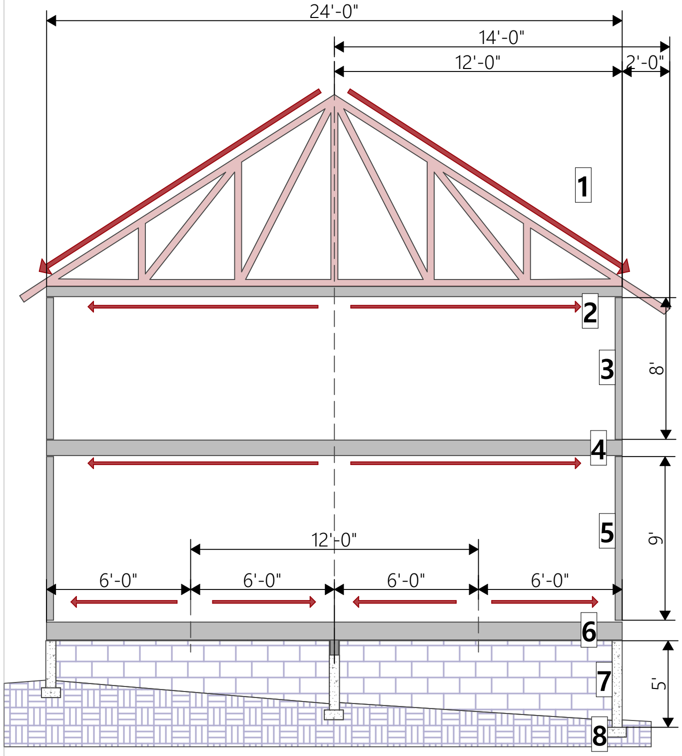


TRIBUTARY LOADING IN BOX CONSTRUCTION

SIMPLE BOX

*BEARING WALLS_all span based tributary loading goes to these (front and rear) outside walls, and the weight of the walls themselves

*NON BEARING END WALLS_these end walls will carry a small amount of roof-1/2 of member centers, likely 1', on the inside, plus any end wall overhang. And they will carry 1/2 of floor joist centers, between 8" and 1' based on floor centers. and all the dead load of the walls down to and including the footing. So, although considered non bearing, there is a load to be considered.



EXTERIOR BEARING WALL

TALLY_THIS SIMPLE CONDITION MERITS SOME NUMBERS BEING USED

1*ROOF
- SNOW LIVE LOAD 30 PSF
- DEAD LOAD 10 PSF
- TOTAL_14' TRIB X 40 PSF = 560 PLF

2*CEIL LOAD
- DEAD LOAD 5 PSF
- TOTAL_12' TRIB X 5 PSF = 60 PSF

3*UPPER FLOOR FRAME WALL LOAD
- DEAD LOAD 15 PSF
- TOTAL_15 PSF X 8'H = 120 PLF

4*UPPER FLOOR LOAD
- LIVE LOAD 30 PSF (SLEEPNG)
- DEAD LOAD_10 PSF
- TOTAL_40 PSF X 12'TRIB = 480 PSF

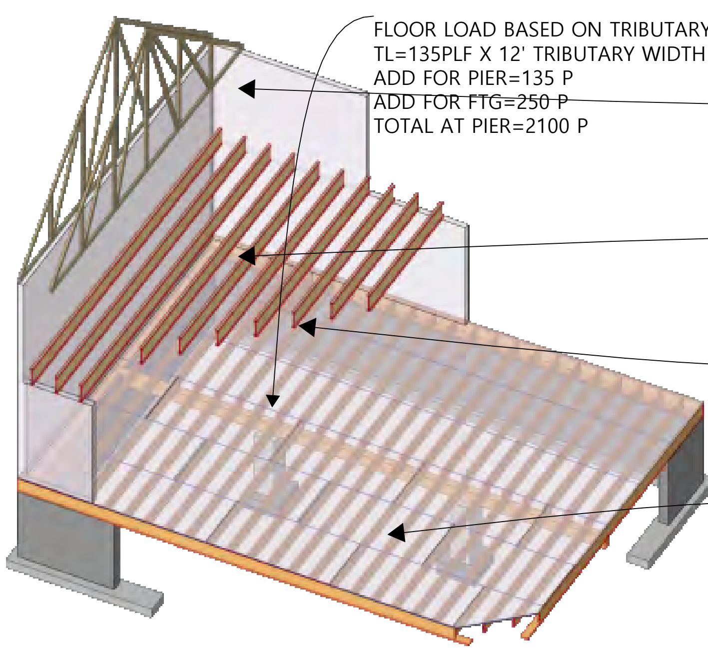
5*MAIN FLOOR FRAME WALL LOAD
- DEAD LOAD 15 PSF
- TOTAL_15 PSF X 9'H = 135 PLF

6*MAIN FLOOR LOAD
- LIVE LOAD 40 PSF (LIVING)
- DEAD LOAD 15 PSF
- TOTAL_55 PSF X 6' TRIB = 330 PLF

7*FOUNDATION WALL LOAD
- DEAD LOAD .66' X 145 PCF=96 PLF
- TOTAL_96 PLF X 4'H = 480 PLF

8*FOOTING LOAD
- DEAD LOAD .66' X 1.33' X 145 PCF = 127 PLF
- TOTAL_127 PLF

***TOTAL LOAD AT GRADE**_2292 PLF



FLOOR LOAD BASED ON TRIBUTARY AREA
TL=135PLF X 12' TRIBUTARY WIDTH=1620 P
ADD FOR PIER=135 P
ADD FOR FTG=250 P
TOTAL AT PIER=2100 P

DIMENSIONAL LUMBER STICK FRAMING PARTS

*END WALL LOADING_noted above. Half the distance from parallel member to wall is carried by the member and half at the wall. Ditto the roof except the entire roof overhang is carried by the wall. These end overhangs could be zero, or typically 1 or 2 '.

*OFF TOPIC_these truss end walls can be just another truss, or an 'end wall' truss, or a frame wall. This illustration shows an end wall truss (there is a gravity load only requirement in this end wall plane) that has been constructed 6" lower for the 2x6 roof outriggers.

*SINGLE SPAN UPPER LEVEL_suggesting engineered joists from front to back. This framing is fast and simple. The trusses above direct all roof loading to front and rear walls. This lighter (sleeping area) load and demand on floor has the full span approach viable.

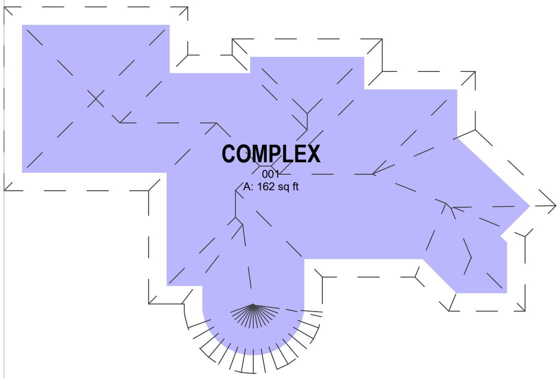
*DOUBLE SPAN LOWER LEVEL_this is showing the most standard condition with dimensional lumber spanning to a center beam (aka girder). In theory this main floor could also be full span because all loading above has been diverted to the front and rear bearing walls. this 24' span on a main living level can work structurally but would be subject to that 'bounce' issue pointed out with the engineered joist summary.

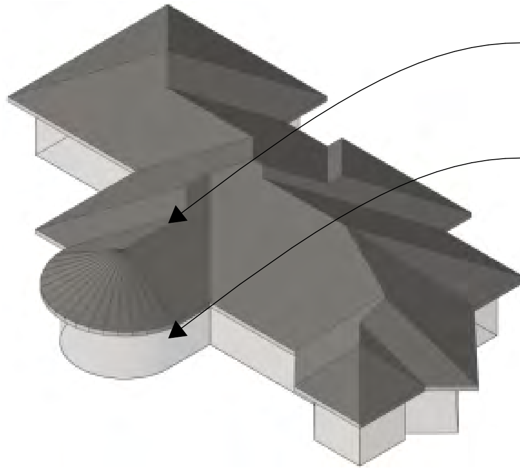
TRIBUTARY LOADING IN COMPLEX CONSTRUCTION

THE JOISTS ARE PART OF A BIGGER SYSTEM

***CORE IDEA_**THE 1/2 SPAN DISTRIBUTION REMAINS THE SAME, EXCEPT IN THIS ILLUSTRATION ITS TRACKING FROM ROOF TO FOOTING IS FAR MORE COMPLICATED.

***BIG PICTURE_**A TOOL MADE AVAILABLE WITH COMPUTER DRAFTING IS BEING ABLE TO 'GHOST' STORIES ABOVE AND BELOW THE STORY RECEIVING THE LOAD. THE EXACT POSITIONING THEN CAN BE SPOTTED.

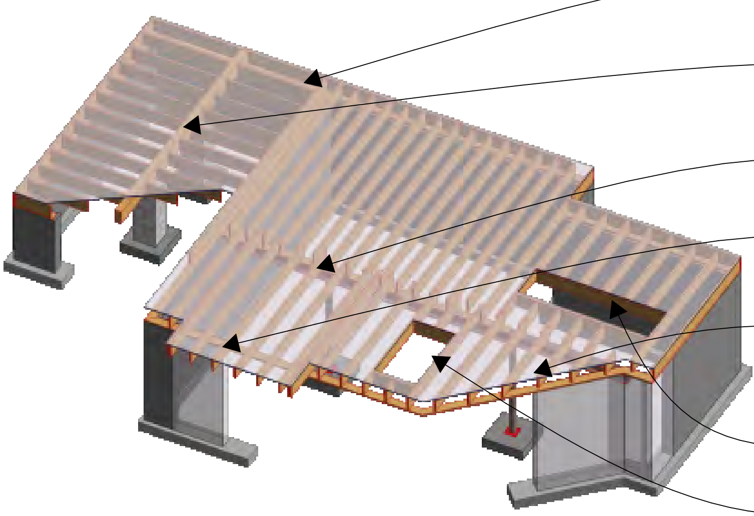




COMPLEX FOOTPRINT

*THIS IMAGE_has been borrowed from the design guide and does not conform exactly with the floor framing images below.

*THIS ROOF_this type of roof gemetry is tricky to load track. The valley members, and a sometimes the hip members, require post supports which introduce point loats frequently in awkward places. Mentioned in more detail (c7, c8). Mentioned here as another reminder that the floor framing always has to take care of itself, and frequently has to take care of loads from above.



MORE COMPLEX FRAMING_LOWER LEVEL

*REVERSING THE FRAMING DIRECTION_default framing is to keep everything running the same direction but sometimes is more economical based on structural requirements/span lengths.

*FLUSH GIRDER_structurally the same requirements (for joists and beam) as with the typical drop beam. A little more care needed with the framing. The joists butting up the girder want to uniformly flush.

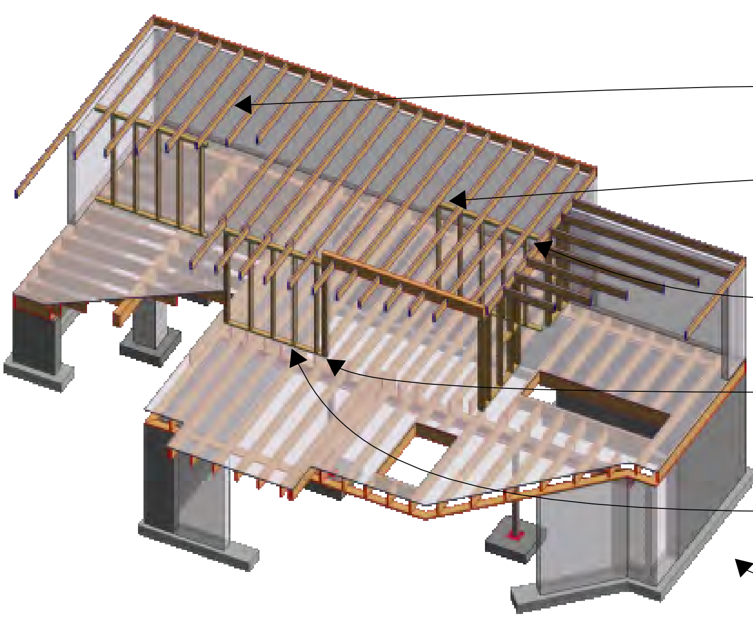
*STANDARD CENTER BEAM_for basement situations the steel beam and posts is an efficient solution.

*CANTILEVER FLOOR_pretty straightforward framing and sometimes a real design asset. There is insulation and (mostly) exterior finishes to consider.

*ANGLED FLOOR_not a structural issue for dimensional lumber or engineered joists, and not a big deal regarding floor framng. tThe angled wall is almost always one that need resolutiion with the roof design (not shown).

*INEFFICIENT OPENING__running perpendicular to the joists requires more substantial headers and runners.

*MORE EFFICIENT OPENING _running wth the joists.



MORE COMPLEX FRAMING_UPPER LEVEL

*FRAME WALLS IN-LINE WITH JOISTS_if required can be additionally supported below with sistered joists. These decisions should be all load based on real calculations and not rules of thumb.

*FRAME WALLS PERPENDICULAR WITH JOISTS_loading can be more complicated. The perpendicular wall creates a point load on each joist it passes over. Where and how big this point load is determines if the bearing joists need any adjustment.

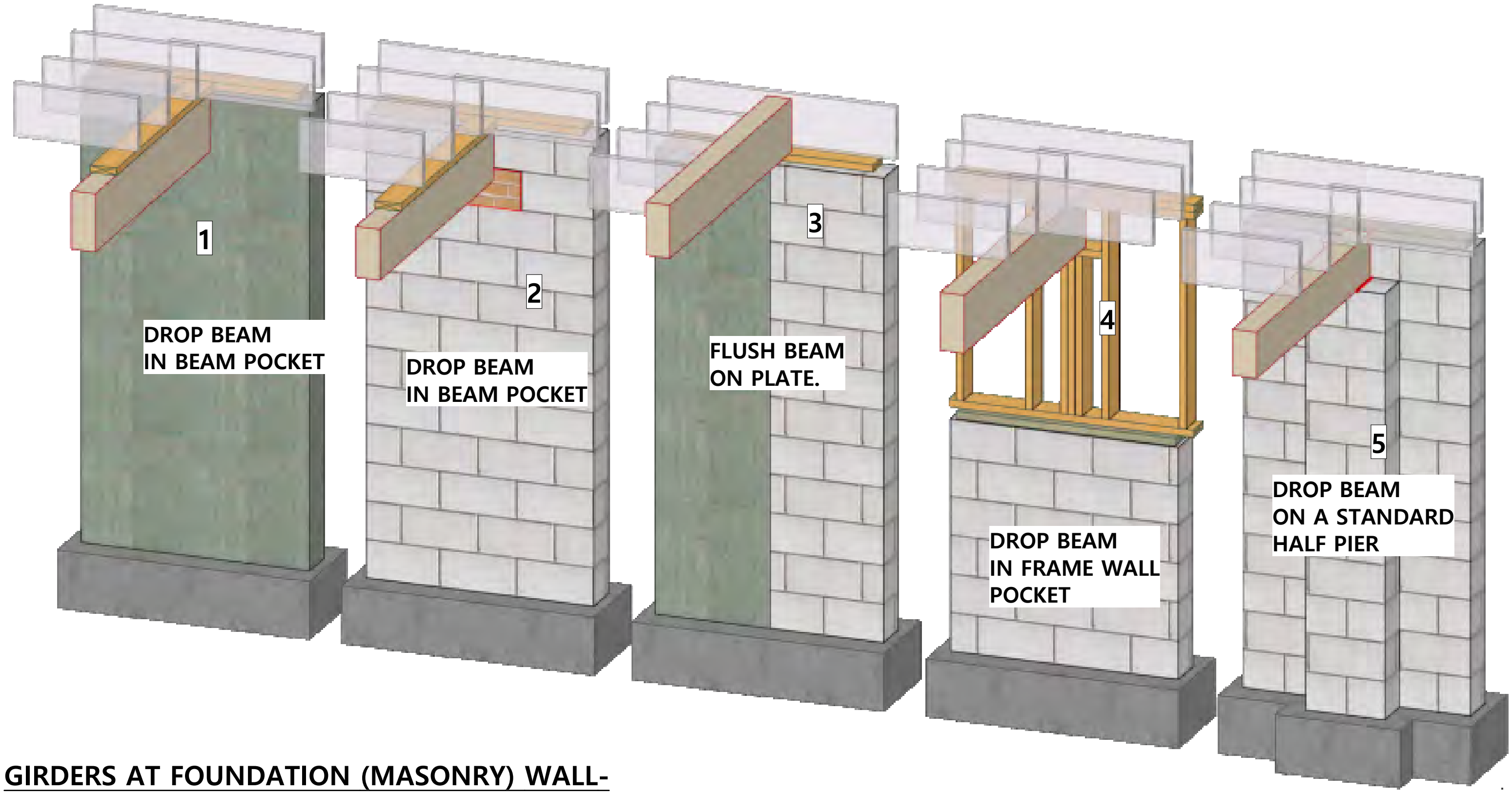
*FRAMING DIRECTION_half the span loading of these reversed joists and half the on center dimension (say 8") contributes to the load on the wall which must be carried by beefing up floor joists below.

*HEADERS CREATE POINT LOADS_all headers divert loads to the bearing 'jacks'. The longer the header the greater the loads. This larger header point load will demand the steel beam below pick up the load.

*IN LINE FRAMING _interior bearing frame wall increases the load on the lower steel beam.

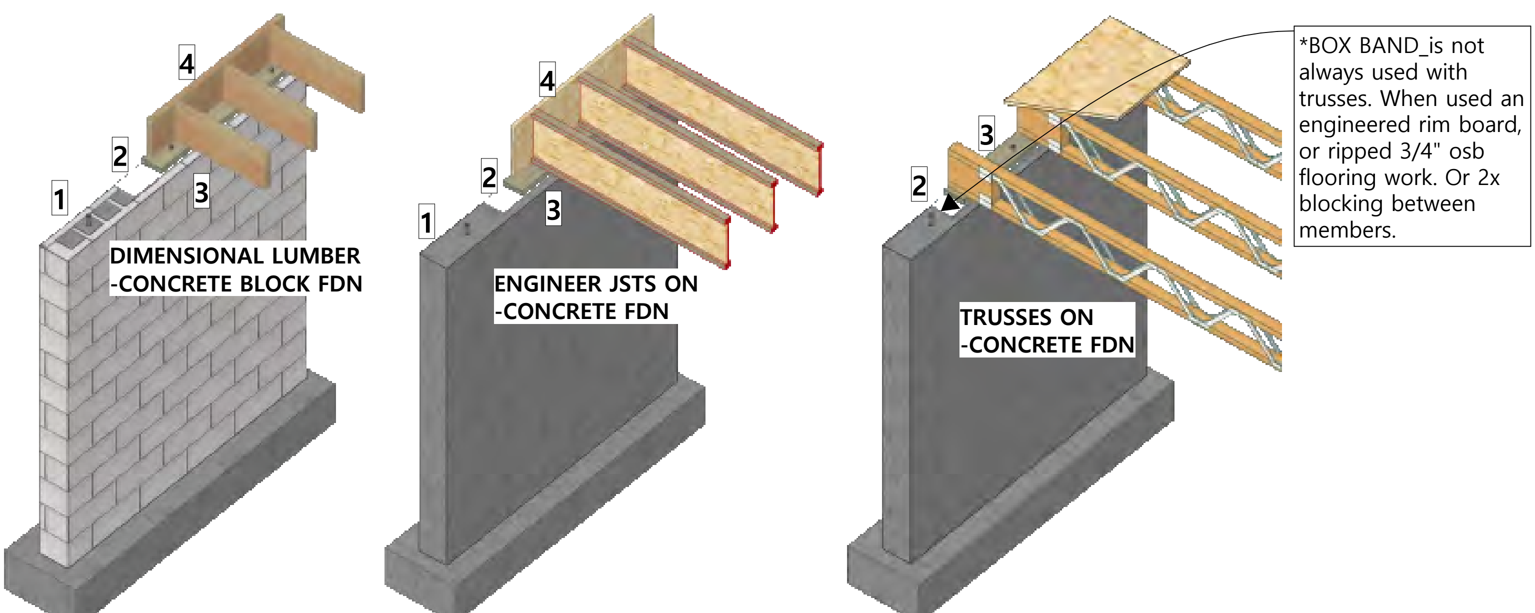
*THE ROOF _which is not included these illustration is where all loading starts. Any load tracking math must start at the roof.

SUPPORTING JOISTS AND GIRDER BEAMS AT FDN WALLS



GIRDERS AT FOUNDATION (MASONRY) WALL-

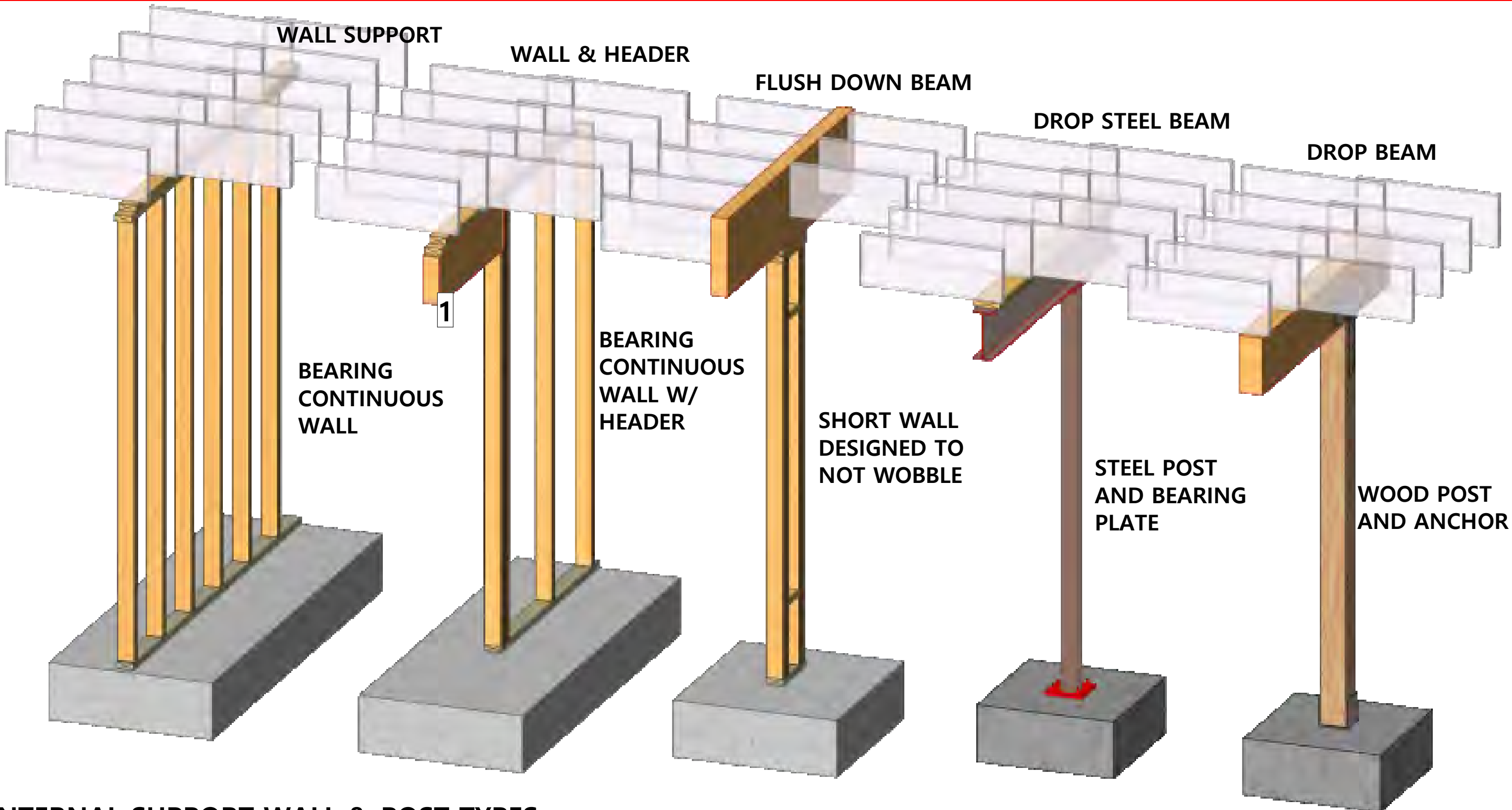
1*CONCRETE WALL BEAM POCKET_BEST TO HAVE THIS FORMED WITH THE WALL CONSTRUCTION. IF IT IS FORMED TOO LOW THE POCKET CAN BE SHIMMED UP. IF IT IS FORMED TOO HIGH IT BECOMES A MESSY PROBLEM.
2*BLOCK WALL BEAM POCKET_GETTING A BEAM TO 'COURSE OUT' WITH THE 8" BLOCK COURSING MAY NOT HAPPEN. STANDARD PROCEDURE IS EITHER CUTTING BLOCK OR USING BRICK TO BUILD UP THE POCKET TO THE CORRECT HT.
3*FLUSH BEAM_SAME CONDTION WHETHER CONCRETE OR BLOCK FOUNDATION WALL, THE BEAMS SIT ON THE SAME PLATE AS THE RIM JOIST/BEARING JOISTS. THIS NECESSITATES THE FLUSH BEAM IS THE SAME DEPTH AS THE JOISTS.
4*FRAME WALL BEAM POCKET_AS IN ANY FRAME WALL ADDITIONAL STUDS WILL WANT TO BE ADDED UNDER THE BEAM.
5*HALF PIER_MOST TYPICAL DROP BEAM SUPPORT IN BLOCK WALL PERIMETER FOUNDATIONS. THE 'ENGAGED' HALF PIER WORKS REGARDLESS OF HT. HALF PIER HT WILL MATCH HT OF ALL INDEPENDENT PIERS.



TYPICAL JOIST AT FOUNDATION WALL

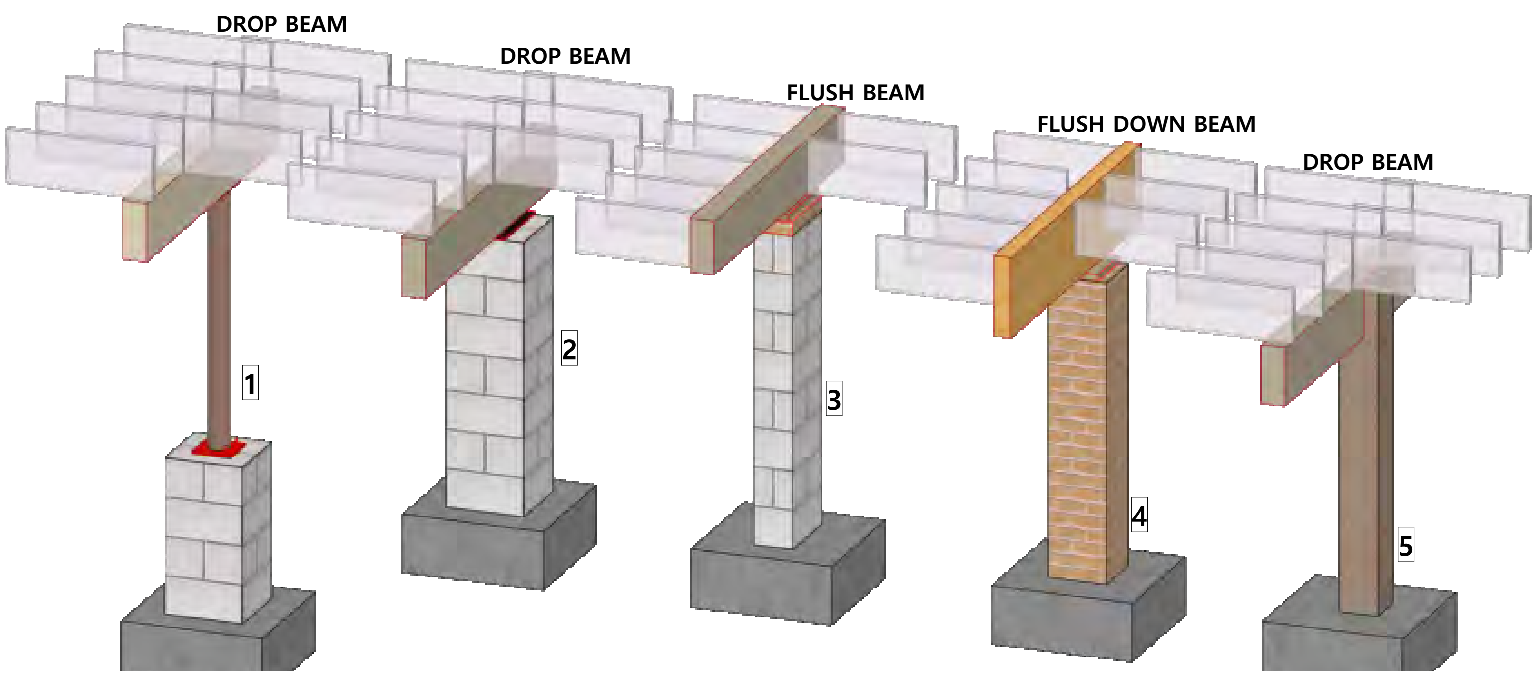
1*IF CONCRETE BLOCK_TOP COURSE FILLED SOLID. ANCHORS BOLTS SET PER LOCAL REQUIREMENT. POURED CONCRETE WALLS ALREADY SOLID.
2*SILL SEAL_SHOWS (WHITE) AND IS A GOOD AND CHEAP SOLUTION TO KEEP PLATE DRY FROM MOISTURE MIGRATION AND CONTROL AIR INFILTRATION. SAME CAN BE ACOMPLISHED WITH TREATED LUMBER PLATES AND CAULK.
3*PLATE_2X DIMENSIONAL LUMBER PLATE DRILLED PER ANCHOR BOLT PATTERN AND SECURED TO FOUNDATION WALL. THIS PLATE IS AN IMPORTANT STRUCTURAL COMPONENT IN HIGH WIND FRAMING AND IS SOMETIMES DOUBLED FOR MORE NAILING AREA FOR OSB.
4*BAND_LOCKS IN THE END OF THE JOISTS. NEEDS TO BE THE SAME HT AS THE JOISTS. aka PERIMETER JOIST, RIM JOIST, BOX JOIST, BOX BAND, RIM BAND. ENGINEERED JST MANUFACTURERS MAKE RIM BOARS STOCK TO MATCH THE VARIOUS JOIST HTS.

SUPPORTING JOISTS AND BEAMS ON WALLS, POSTS, PIERS



INTERNAL SUPPORT WALL & POST TYPES

1*COMMON REQUIREMENTS_ALL EXAMPLES ARE STRUCTURALLY ADEQUATE WHEN DESIGNED FOR LOADS. AND ALL REQUIRE CONCRETE SUPPORT BELOW. THE WALL SPREADS THE LOADS. THE POST(S) CONCENTRATE THE LOADS. ALL WOOD SOLUTIONS NEED PROTECTION AT BASE FROM MOISTURE MIGRATION FROM CONCRETE. TREATED WOOD PLATES AT THE FLOOR SHOW WHICH IS COMMON.



PIER TYPES TYPICAL IN CRAWL SPACE FOUNDATIONS-

*ALL THESE PIERS HAVE MORE THAN ENOUGH CAPACITY TO CARRY THE LOAD FROM BEAM TO FOOTING, **AND** ENOUGH SQ INCHES OF BEARING TO SPREAD THE LOAD THROUGH FOOTING TO GRADE

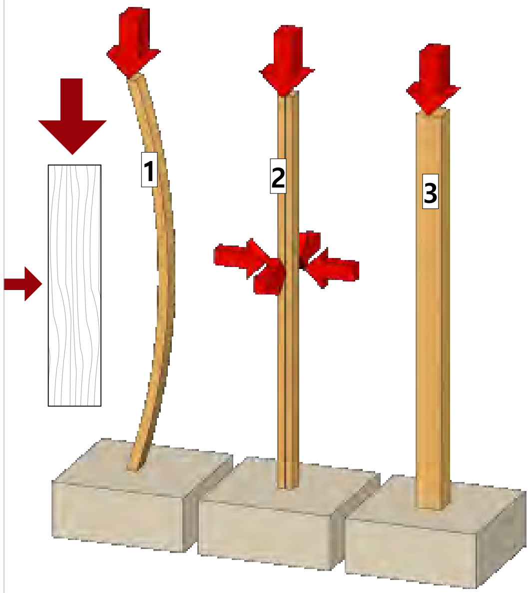
1*COMPOSITE PIER_EFFECTIVE WITH TALL CRAWL SPACES USING AN EFFICIENT STEEL POST FROM BLOCK PIER BASE UP TO FLOOR GIRDER SUPPORT.

2*16"X16" BLOCK PIER_POSSIBLY THE MOST STANDARD PIER TYPE. IT IS OVERSIZED STRUCTURALLY BUT HARD TO KNOCK OVER DURING CONSTRUCTION ACTIVITY AND FORGIVING IF NOT PRECISELY LOCATED.

3*8"X16" BLOCK PIER_STRUCTURALLY ADEQUATE BUT EASIER TO KNOCK OVER AND NOT VERY FORGIVING IF NOT PRECISELY LOCATED.

4*BRICK PIER_BRICK (OR CONCRETE BRICK) CAN BE 8" OR 12" SQUARE. A LITTLE MORE LABOR AND MATERIAL COST.

5*TIMBER PIER_8X8 OR 6X6_TRICKIER TO STABILIZE DURING THE FRAMING PROCESS.



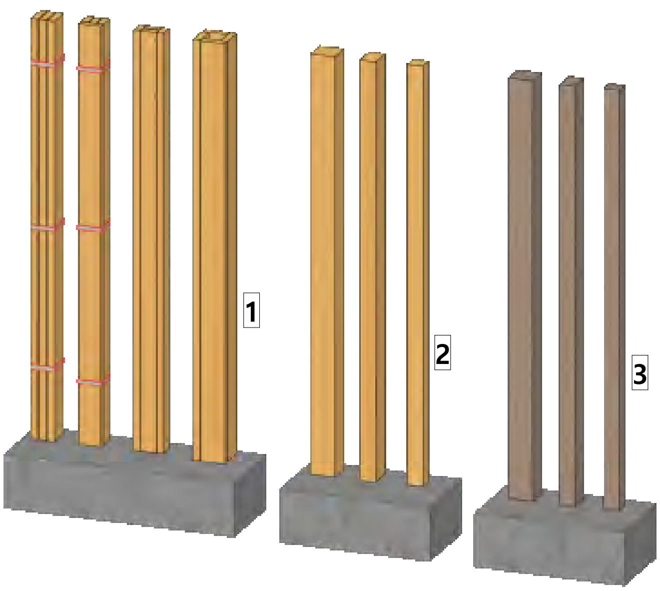
WOOD SUPPORT POST THINKING

***GENERAL_**WOOD HAS SO FAR BEEN NOTED AS FAIRLY EFFECTIVE IN TENSION WHEN LOADED IN THE HORIZONTAL POSITION. WHEN EMPLOYED AS A POST THE BEHAVIOR IS DIFFERENT. WOOD ACTUALLY CAN TAKE A GOOD LOAD IN (END) COMPRESSION (ABOUT 1300 PSI) BUT CAN GET WOBBLY.

1*SLENDERNESS_THE SLENDERNESS RATIO IS A RELATIONSHIP BETWEEN COLUMN HT AND CROSS SECTION. LOGIC SAYS TALL AND THIN IS SUBJECT TO BENDING/BUCKLING, SHORT AND FAT IS NOT SUBJECT TO BENDING/BUCKLING. THIS IS TRUE OF ANY COLUMN TYPE. WOOD IS

2*CONTROLLING THE WOBBLES_IF THE SLENDER POST IS 'BRACED' NEAR THE MIDPOINT IT WON'T WOBBLE. THIS MAY OR MAY NOT BE A REASONABLE IN PLACE SOLUTION.

3*HEIGHT & GIRTH_WHEN A POST CANNOT BE BRACED AGAINST THE 'WOBBLES', A MORE SQUARE AND LARGER CROSS SECTION CAN BE CHOSEN. 6X6 POSTS ARE SIGNIFICANTLY BETTER AT MANAGING BENDING/BUCKLING THAN 4X4 POSTS.



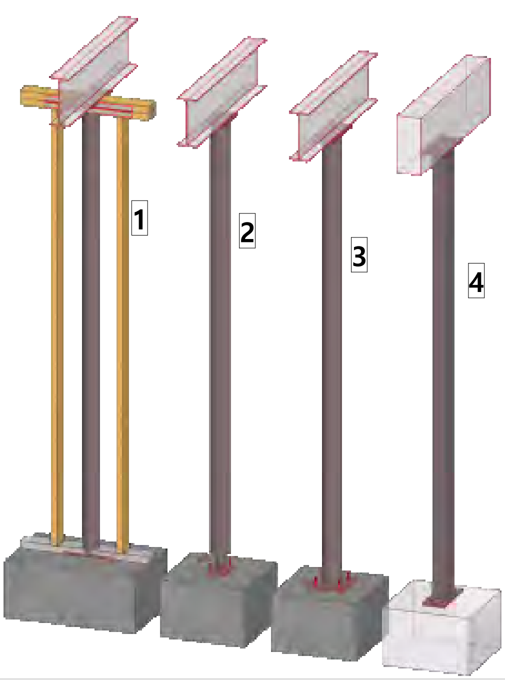
WOOD SUPPORT POSTS

***GENERAL_**COMMENTS ARE GENERIC.

1*BUILT UP DIMENSIONAL LUMBER_THERE ARE LOTS OF WAYS TO PUT 2X DIMENSIONAL MEMBERS TOGETHER TO CREATE A STRONGER 'BUILT-UP' POST. FASTENING/STRAPPING ARE VERY IMPORTANT AS WE WANT THE POST TO ACT AS A SINGLE UNIT- & NOT A BUNCH OF INDEPENDENT PIECES. CHANGING THE DIRECTION OF THE DIMENSIONAL PIECE ALSO HELPS TO INCREASE THE CAPACITY IN BOTH DIRECTIONS.

2*SINGLE PIECE WOOD_4X4,4X6,6X6 ARE COMMON SMALL DIMENSION SINGLE PIECE POST DIMENSIONS. 8X8 ARE OFTEN AVAILABLE FOR EXTERIOR DECK/PORCH CONSTRUCTION

3*ENGINEERED WOOD POSTS_THE SAME INDUSTRY THAT PRODUCES ENGINEERED FLOOR JOISTS AND LVL BEAMS PRODUCE ENGINEERED POSTS. FIBERS ARE GLUE TOGETHER TO INCREASE THAT CAPACITY TO RESIST BENDING/BUCKLING. AND THEY ARE MANUFACTURED STRAIGHT AND (MOSTLY) STAY STRAIGHT. BY COMPARISON IT IS DARN HARD TO FIND A NATURAL WOOD POST THAT IS LONG AND STRAIGHT.



STEEL POSTS

***GENERAL_**STEEL POSTS ARE SIGNIFICANTLY MORE LOAD CAPABLE THAN WOOD POSTS. THEY ARE TYPICALLY SELECTED BECAUSE LOADS ARE GREATER, A CHALLENGE EXISTS IN MANAGING THAT SAME BIGGER LOAD IN THE TOP AND BOTTOM SUPPORT DETAILS. A BIG LOAD ON A SMALL STEEL POST COULD PUNCH THRU A CONCRETE SLAB WITHOUT A DISTRIBUTION PLATE. AND A BIG LOAD ON A WOOD BEAM RESTING ON A SMALL STEEL POST MAY 'CRUSH' THE WOOD FIBERS.

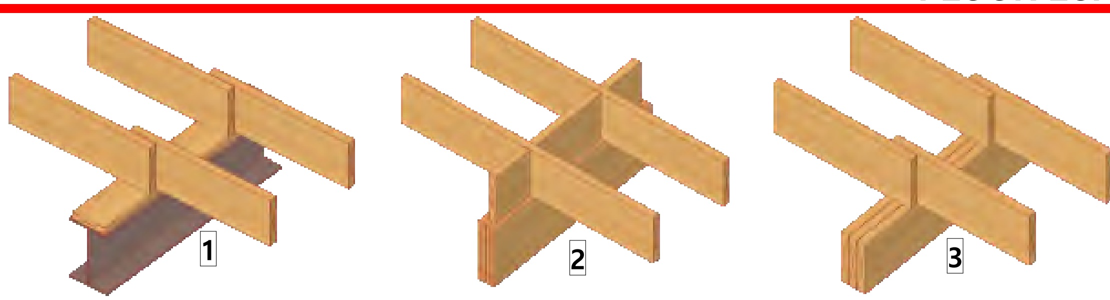
***TOP AND BOTTOM BEARING PLATES_**DISTRIBUTE THAT LOAD FROM BEAM TO POST AND POST TO CONCRETE. STEEL THICKNESS AND PLATE SIZE BASED ON LOADING,

1*BURIED IN WALL_3" DIA OR 3.5" DIA ROUND STEEL COLUMNS CAN FIT WITHIN A TYPICAL 2X4 WALL. THE POST WILL SIT ON THE FLOOR PLANE, AND RUN TO THE BOTTOM OF THE BEAM ABOVE. THE 2X4 WALL IS STOPPED AND STARTED EACH SIDE OF THE STEEL POST. THE TOP PLATES ARE USUALLY 'MENDED' WITH STRAPPING/PLATES.

2*ADJUSTABLE 'PIPE' COLUMN_THE ADJUSTABLE PIPE COL. HAS BEEN AROUND A VERY LONG TIME AND IS A FREQUENT SELECTION WHEN SUPPORTING BASEMENT BEAMS WHETHER WOOD OR STEEL. THEY ARE STRONG ENOUGH, EASY TO INSTALL AND CHEAP. THE SCREW ADJUSTMENT AT THE BOTTOM TAKES CARE OF THE ALWAYS POSSIBLE LEVEL DISCREPANCIES BETWEEN SLAB AND BEAM.

3*ROUND STEEL COLUMN_ARE AVAILABLE IN MANY/MANY DIAMETERS AND STEEL WALL THICKNESSES. THE ROUND SHAPE IS STRUCTURALLY EFFICIENT.

4*SQUARE OR RECTANGULAR TUBE STEEL COLUMN_SIMILARLY ALSO AVAILABLE IN MANY SIZES AND STEEL WALL THICKNESSES.

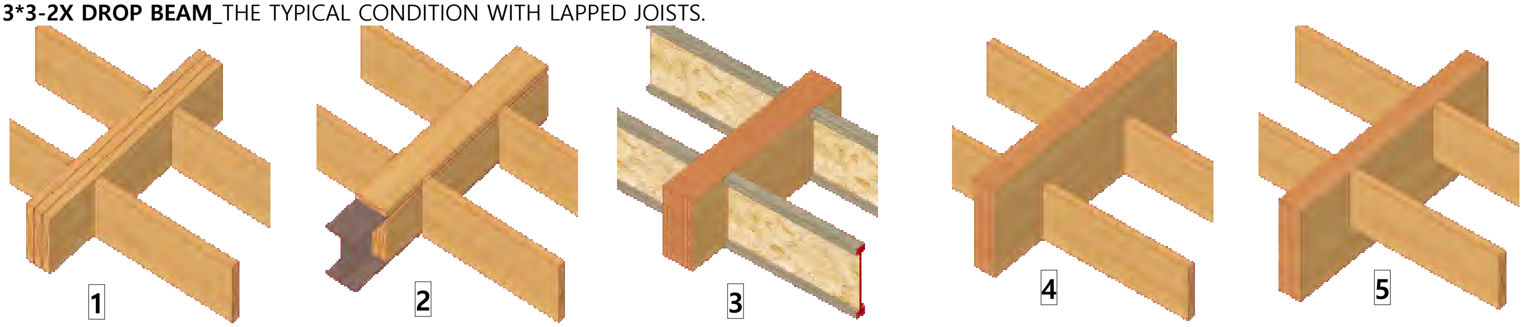


DROP BEAMS **WHEN THE DROP BEAM IS NOT A DESIGN PROBLEM**

1*STEEL_TYPICAL TO SET HTS TO ALLOW FOR A WOOD PLATE TO SIT ON TOP OF THE STEEL FOR SOMETHING TO NAIL TO.

2*DBL DROP LVL WITH ALIGNED JSTS_KEEPING JOISTS IN ALIGNMENT POSSIBLE IF $1^{1/2}$"OF BEARING IS ACHIEVED FOR EACH JOIST. BLOCKING REQUIRED TO KEEP EVERYTHING STANDING UP AND IN ALIGNMENT. FUSSIER JOIST LABOR- BUT NO $1^{1/2}$" OFFSET WITH THE ABOVE SHEATHING LAYOUT.

3*3-2X DROP BEAM_THE TYPICAL CONDITION WITH LAPPED JOISTS.



OTHER BEAM POSITIONS **HANGERS DO NOT SHOW THESE ILLUSTRATIONS. SEE BELOW**

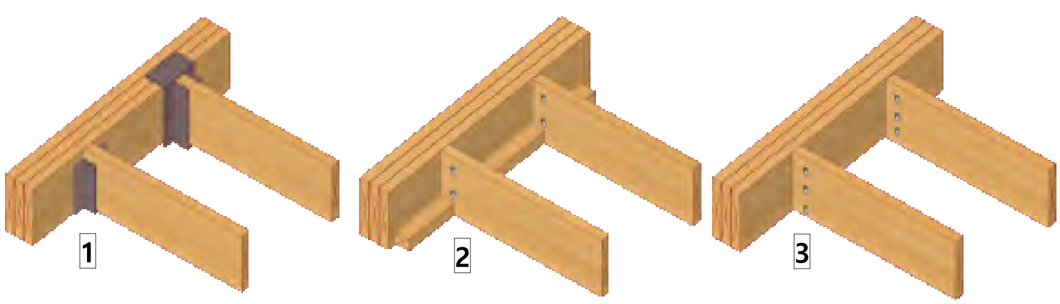
1*FLUSH DIMENIONAL LUMBER BEAM_STANDARD FLUSH CONDITION FOR DIMENSIONAL LUMBER. SEE CONNECTION OPTIONS BELOW.

2*FLUSH STEEL BEAM_AN 8" DEEP STEEL BEAM CAN GET BURIED IN A 10" FLOOR, A 10" STEEL BEAM CAN GET BURIED IN A 12" FLOOR. THE STEEL WANTS THAT PLATE ON TOP AND THRU BOLTED BLOCKING EACH SIDE OF THE WEB FOR FACE MOUNT HANGERS. TOP HANGERS FOR THE JOISTS DON'T REQUIRE THE BLOCKING.

3*FLUSH LVL BEAM_THE DEEPER ENGINEERED JOISTS AND MATCHING DEPTH LVLS OPEN THE SPAN CAPABILITIES UP A LOT. PRETTY SIMPLE ARRANGEMENT WITH NO FUSSING ABOVE AND BELOW.

4*FLUSH (LVL) BEAM UP_THIS ARRANGEMENT VIABLE WHEN NO ACTIVE FLOOR IS ABOVE SO APPLICABLE IN ATTIC CONDITIONS.

5*FLUSH (LVL) BEAM DOWN_WHEN A DROP BEAM CAN BE DESIGN INTEGRATED THIS IS VIABLE FOR LONGER SPAN CONDITIONS WHERE THAT LVL DEPTH IS REQUIRED.

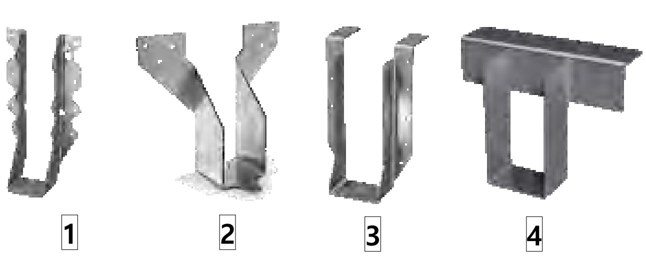


FLUSH CONNECTIONS TYPES

1*HANGERS_TYPICAL METHOD FOR FLUSH CONNECTIONS. FACE HANGERS AND TOP HANGERS ARE THE 2 FORMATS. SEE BELOW

2*LEDGER_TRADITIONAL WAY OF A FLUSH BEARING COMNNECTION. LEDGER IS USUALLY 2X2 AND CONTINUOUSLY FASTENED FLUSH WITH THE BOTTOM OF THE BEAM MEMBER. EACH JOIST IS NOTCHED TO FIT. BEARING IS THE $1^{1/2}$"AT THE NOTCH. TOE NAILS FOR KEEPING JOIST SQUARE.

3*TOE NAILS_NOT PERMITTED FOR FLOOR APPLICATIONS. TOE NAILS ARE INCONSISTENT STRUCTURALLY. CEILING JOISTS APPLICATIONS AND ANY (ESSENTIALLY) NON LOAD BEARING CONDITIONS PERMITTED.



HARDWARE HELP-HANGERS

***GENERAL**_HANGERS ALLOW FOR ALL SORTS OF JOIST TO JOIST/JOIST TO BEAM/BEAM TO BEAM CONNECTIONS TO HAPPEN PRETTY EASILY AND MEETING STRUCTURAL LOADING REQUIREMENTS. THERE ARE DOZENS OF CHOICES MEETING VIRTUALLY ALL TYPICAL SCENARIOS. SIMPSON 'STRONG TIE' IS ONE OF THE COMPANIES WITH EXHAUSTIVE OFFERINGS.

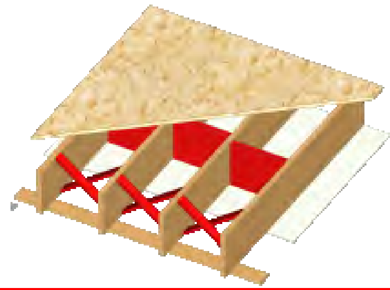
1*FACE MOUNT STANDARD SINGLE JOIST
2*FACE MOUNT HEAVIER DUTY
3*TOP FLANGE LIGHTER DUTY
4*TOP FLANGE HEAVIER DUTY

SYSTEMS APPROACH TO REPETITIVE FRAMING

*A FRAME FLOOR PLATFORM WILL PERFORM BETTER WHEN IT IS WORKING AS A SINGLE ENTITY. SO IF THE SHEATHING STAYS STIFF, IF THE JOISTS STAY PLUMB AND HELP EACH OTHER OUT, THAT WILL HAPPEN.

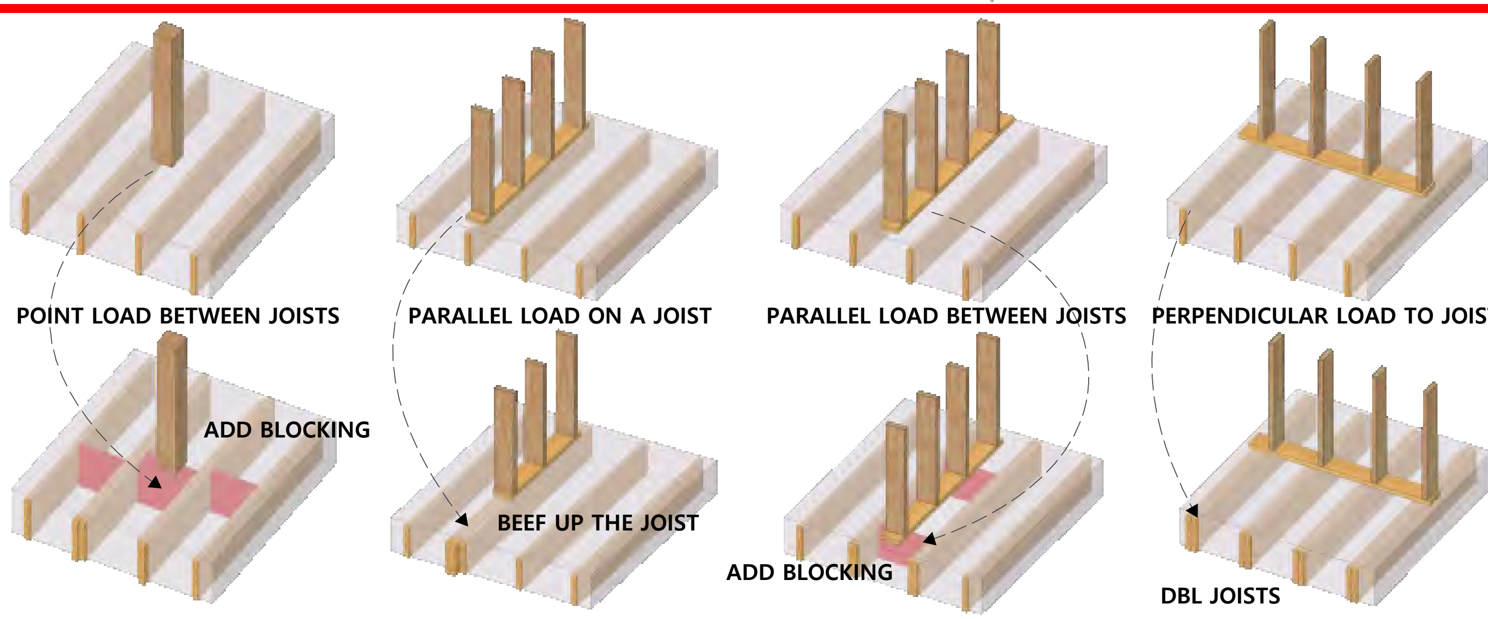
A SLOPPY FLOOR

***SHEATHING_**TOO FLIMSY
***JOISTS WITHOUT GUIDANCE_**
WIDER CENTERS, LONGER SPANS, AND NO BOTTOM CONNECTION PERMIT EACH JOIST TO ACT ON ITS OWN. THEY CAN ROTATE/GET A LITTLE SQUIRRLY. WHEN OUT OF PLANE THEY GIVE AWAY SOME STRENGTH.



A UNIFIED FLOOR

***SHEATHING_**THICKER, TONGUE AND GROOVE DESIGN.
***JOISTS WITH GUIDANCE_**SOLID BLOCKING, BRIDGING, AND BOTTOM CEILING SURFACE OR BRACING ARE 3 WAYS OF KEEPING JOISTS PLUMB AND WORKING TOGETHER.

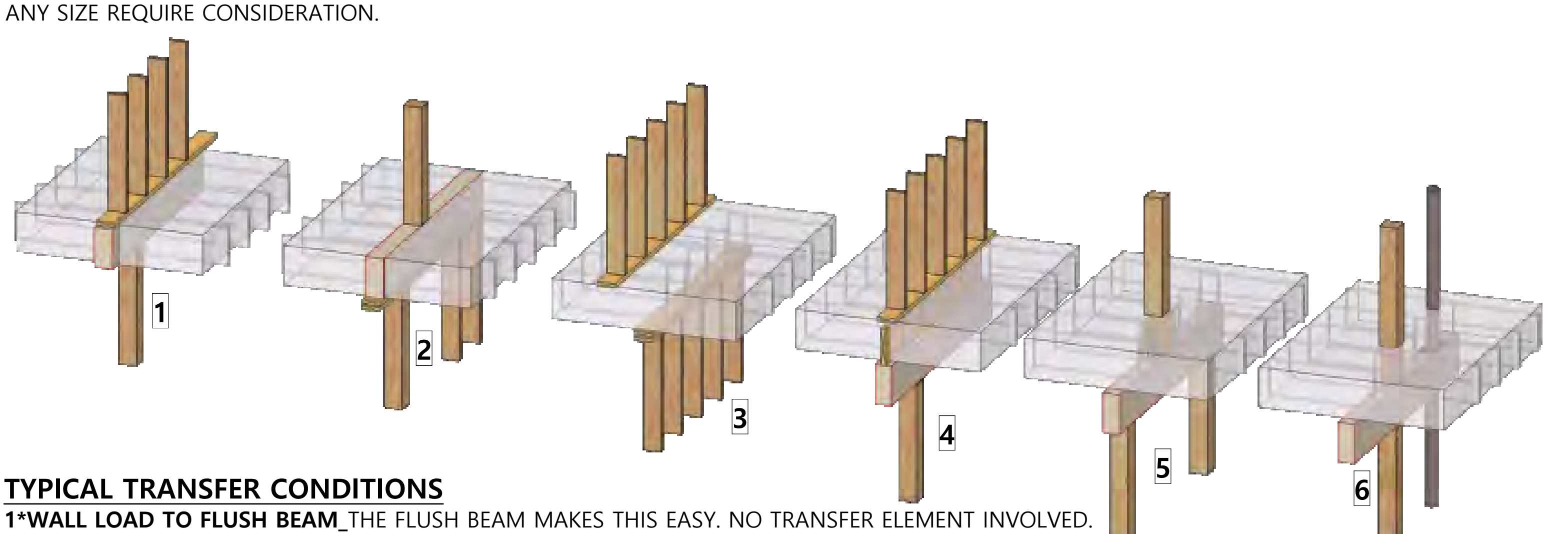


MANAGING LOADING ON REPETITIVE MEMBER FRAMING

*WHETHER DIMENSIONAL LUMBER, ENGINEERED JOISTS, OR FLOOR TRUSSES, ARE DESIGNED ESSENTIALLY FOR UNIFORM LOADING BASED ON THE DESIGNED FOR LIVE AND DEAD LOADS. SO ANY ADDITIONAL LOADING NEEDS CONSIDERATION. ALL THESE INSTANCES SHOWN ARE COMMON. THESE SOLUTIONS SHOW CONCEPTUAL INTENT ONLY. THESE ARE ALL WHOLLY CONDITIONAL ON ACTUAL LOADS AND SPANS.

TRANSFERING LOADS THRU A FRAME FLOOR

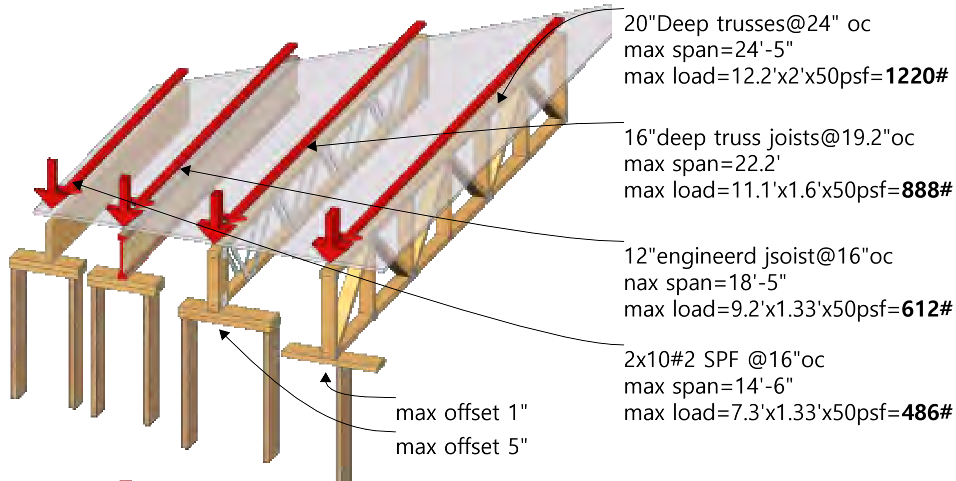
*FRAME FLOORS ARE NOT SOLID. SHEATHING THAT SPANS JOIST TO JOIST MAY LOOK SOLID FROM THE TOP-BUT IS ONLY 3/4" THICK. LOADS OF ANY SIZE REQUIRE CONSIDERATION.



TYPICAL TRANSFER CONDITIONS

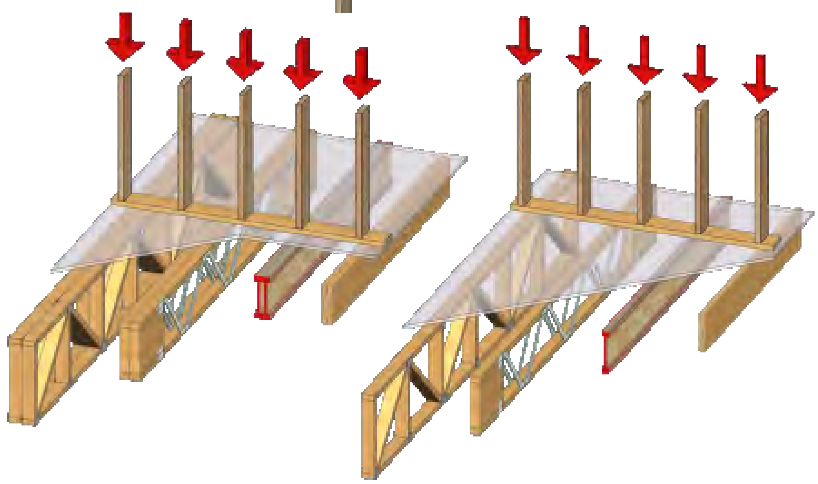
1*WALL LOAD TO FLUSH BEAM_THE FLUSH BEAM MAKES THIS EASY. NO TRANSFER ELEMENT INVOLVED.
2*POST LOAD TO FLUSH BEAM_THE FLUSH BEAM MAKES THIS EASY-NO TRANSFER ELEMENT INVOLVED.
3*OFFSET LOADS_RULE OF THUMB IS BEARING WALL OFFSETS UP TO THE DIMENSION OF THE DEPTH OF JOISTS ARE PERMITTED. SO FOR 2X10 JOISTS A 9.25" OFFSET PASSES MUSTER WITHOUT SPECIFIC STRUCTURAL VERIFICATION.
4*WALL LOAD TO DROP BEAM_THIS SHOWS A SINGLE ROW OF BLOCKING BETWEEN JOISTS TO TRANSFER WALL LOAD TO DROP BEAM. WITH DIMENSIONAL JOISTS THIS IS NOT NECESSARILY REQUIRED. WITH DEEPER ENGINEERED JOISTS USUSALLY ADVISEABLE.
5*POST LOAD TO DROP BEAM_BLOCKING (THE WIDTH OF THE POST) REQUIRED TO TRANSFER LOAD. FINE UNDER MOST RESIDENTIAL LOADS.
6*DIRECT POST LOAD TO DROP BEAM_CARRYING A POST DOWN THRU THE FLOOR TO BEAR DIRECTLY ON THE BEAM IS SOMETIMES DONE WHEN LOADS ARE SUBSTANTIAL.

FLOOR LOADING CONDITIONS 3



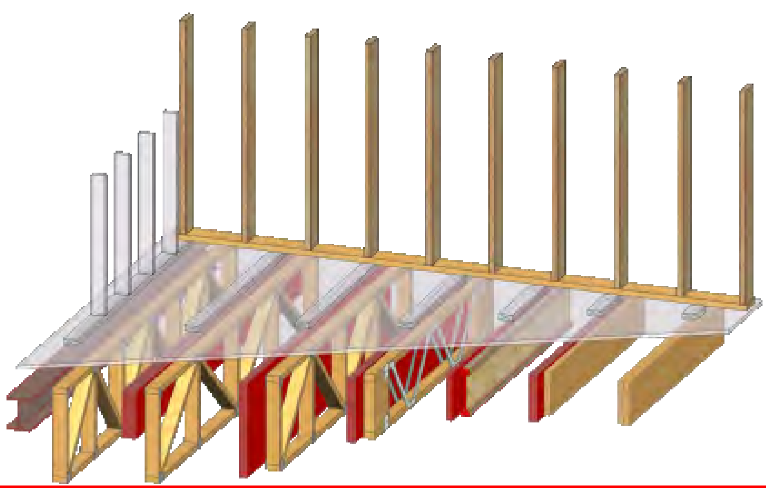
LOADS AT END OF SPAN

***LOAD AT THE BEARING WALL**_THE HALF SPAN X THE CENTER SPACING X THE FLOOR LOAD = THE LOAD AT THE BEARING WALL. SO A LONG SPAN TRUSS AT 2' OC IS TRANSFERING A SIGNIFICANTLY LARGER LOAD THAT A SHOTER SPAN 2X10.
***STUD WALL CONDITIONS**_SOME CONCERNS DO EXIST AT THE WALL FRAMING WHEN FRAMED AT 24" OC. WITH DOUBLE PLATE FLOOR LOAD MEMBERS MUST BE WITHIN 5" OF A STUD. WITH SINGLE PLATE CONSTRUCTION WITHIN 1" OF FLOOR LOAD MEMBER.



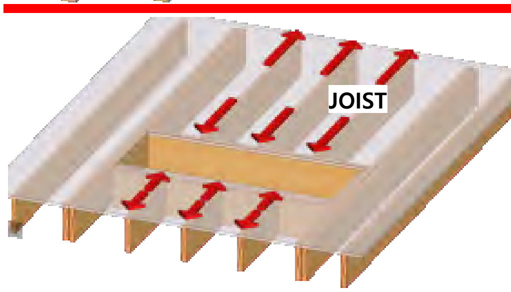
PERPENDICULAR LOADS CAPACITY

***LOAD LOCATION**_THE FARTHER FROM END SUPPORTS, UP TO THE MOST VULNERABLE MID SPAN, THE MORE CHALLENGED THE SPAN MEMBERS BECOME. SOME LOADING NEAR THE END SUPPORTS MAY SURVIVE WITHOUT ASSISTANCE. OTHER LOADS NEARER THE MID SPAN WILL LIKELY NEED ASSISTANCE.
***DOUBLES+**_ONE ADVANTAGE TO 'GANGING' TRUSS MEMBERS IS THEIR WEB OPENINGS STAY IN ALIGNMENT, SO IF NEEDED, THEY ARE VIABLE. GANGING ENGINEERED JOISTS ADDS SOME MODEST STRUCTURAL VALUE. AGAIN ONE BEAUTY OF THE ENGINEERED SYSTEM IS THAT LVL'S ARE AVAILABLE IN THE EXACT SAME DEPTH SO KEEPING A FLOOR PLANE'S DEPTH CONSISTENT IS EASY. DIMENSIONAL LUMBER CAN LIKEWISE BE GANGED.

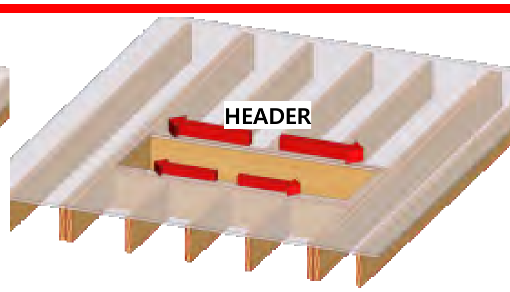


ENHANCING PARALLEL LOADS CAPACITY

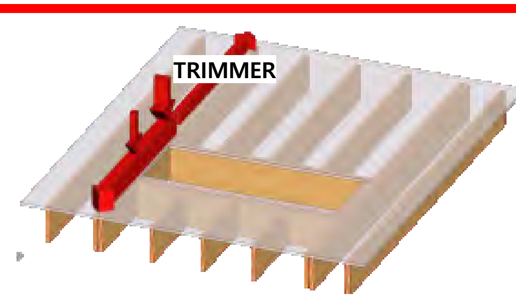
***MEMBER DEPTH**_RECOGNIZED IS THAT DEEPER MEMBERS ARE STRONGER. SO FULL DEPTH PARALLEL ASSISTING MEMBERS- PARTICULARLY LVL MEMBERS- CAN SOLVE LOAD PROBLEMS. THOSE LVLS ARE AVAILABLE UP TO 24" DEEP AND MORE CAPABLE OF HANDLING POINT LOADS FROM ABOVE.
***TRUSS MEMBERS**_OFTEN DEEPER TRUSSES ARE USED FOR LONGER SPANS OR TO FACILITATE PASSING DUCTWORK. IN THOSE CASES A SUPPLEMENTAL BEAM MUST BE SHALLOWER SO ADEQUATE PASSAGE REMAINS. NOTE THE LVL'S AND STEEL BEAMS TO THE LEFT. THS EMPHASIZES AGAIN THE IMPORTANCE OF HAVING HVAC DESIGN DONE DURING THE PLANNING PHASE`



***JOISTS DISTRIBUTE FLOOR LOAD TO THE HEADER USING THE 1/2 SPAN RULE.**



***HEADER DISTRIBUTES JOIST LOAD TO THE TRIMMERS USING THE 1/2 SPAN RULE.**

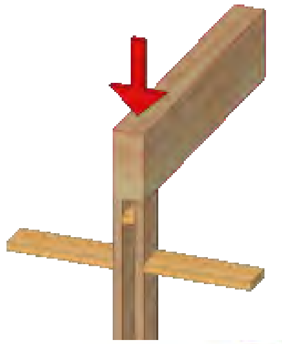


***TRIMMER DISTRIBUTES HEADER LOAD TO WALLS. 1/2 SPAN RULE HERE COMPLICATED BY THE 2 POINT LOADS. LOGIC SAYS MORE LOAD WILL GO TO THE 'FRONT' WALL BECAUSE OF THEIR POSITIONING ON THE BEAM.**

OPENINGS IN THE FLOOR

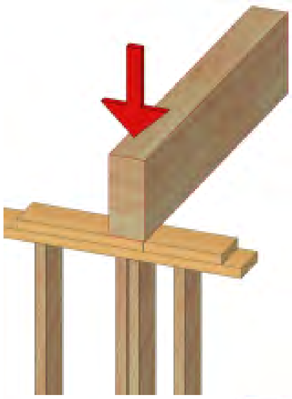
***GENERAL**_ALL OPENINGS SHARE THIS DISTRIBUTION SEQUENCE. JOIST TO HEADER TO TRIMMER. THESE OPENINGS MAY BE FOR A SMALL ACCESS OPENING TO ATTIC, A MEDIUM SIZE STAIR OPENING OR A BIG RAISED CEILING HOLE. LOADS, SPANS, AND MEMBER REQUIREMENTS WILL VARY.

FRAME FLOORS c5.20
FLOOR LOADING CONDITIONS 4



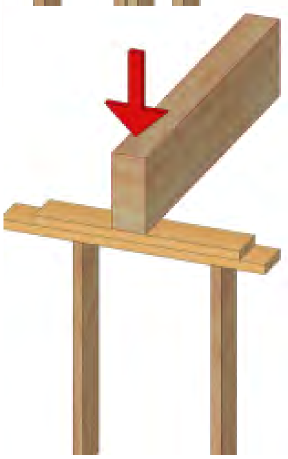
BEAM+POST

***POST**_NOTED ALREADY STUDS CAN HANDLE A GOOD BIT OF LOAD IF THE WOBBLE IS CONTROLLED WHICH IS EASILY DONE WITHIN A WALL CONSTRUCTION.
***NO CRUSH**_END GRAIN LOADING - COMPRESSION PERPENDICULAR TO THE GRAIN-IS NOT LIKELY TO CAUSE ANY CRUSH.



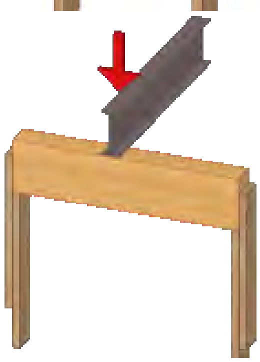
BEAM+PLATE

***PLATES**_DOUBLE PLATE, BUT JOINT ON TOP PLATE IS OF NO BENEFIT IN SPANNING STUD TO STUD
***DIRECT SUPPORT**_SO THE 1 EFFECTIVE PLATE CANNOT TRANSFER LOAD, HENCE STUDS ADDED UNDER BEAM ARE REQUIRED
***CRUSH**_OF WOOD FIBERS ON THE BEAM OR THE PLATE IS POSSIBLE



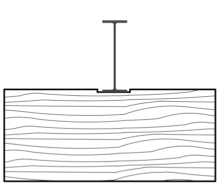
BEAM+PLATE

***PLATES**_DOUBLE PLATE ESSENTIALLY SPANING STUD TO STUD AS A CONTINUOUS BEAM.
***DIRECT SUPPORT**_A SINGLE JOIST IS ACCEPTABLE IN THIS POSITION. A LOADED BEAM MAY BE OK STRUCTURALLY. MOST CEO'S WILL REQUEST A DBL STUD UNDER THIS BEAM, OR ENGINEERING VERIFICATION.
***CRUSH**_OF WOOD FIBERS ON THE BEAM OR THE PLATE IS POSSIBLE



BEAM+HEADER

***HEADER**_THIS IS ONE OF THE FEW INSTANCES WHERE HORIZONTAL SHEAR BECOMES POSSIBLE IN NON ENGINEERED WOOD MEMBERS. BIG LOAD/SHORT SPAN.
***CRUSH**_OF WOOD FIBERS ON THE HEADER IS POSSIBLE. THE STEEL WILL NOT CRUSH. THIS WOULD BE WHERE A BEARING PLATE ON THE TOP OF HEADER WOULD APPLY.



CRUSH

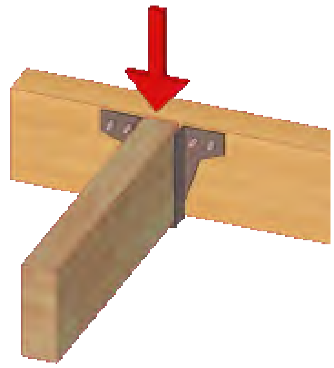
***IN WOOD**_CRUSH IS THE STREET TERM-AND IS POSSIBLE IN A LOT OF CIRCUMSTANCES. PUTTING HEAVY CONCENTRATED LOADS ON THE SIDE SURFACES OF WOOD IS ONE PLACE IT CAN HAPPEN. THE FIBERS CRUSH AND THE BEAM DROPS A BIT WHICH CAN GET A FLOOR PLANE OUT OF LEVEL

CRUSH NUMBERS

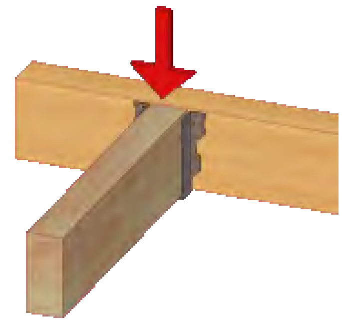
***#2 FRAMING LUMBER**_CAN RESIST (SAY) 425 PSI PERPENDICULAR TO THE GRAIN. LOAD DIVIDED BY THE BEARING AREA = THE RESISTANCE REQUIREMENT PER SQUARE INCH. IF IT EXCEEDS THE 425 PSI THEN CRUSH IS POSSIBLE. (c6.1X) DESCRIBES THIS IN THE CONTEXT OF BEARING CAPACITY OF HEADERS.

SHEAR AND HARDWARE CONNECTIONS

***HANGERS**_ARE A GREAT PLACE TO EXPLAIN THIS SHEAR BEHAVIOR. HANGERS AS A CATAGORY ADDRESS VERTICAL GRAVITY LOADS AND VERTICAL SHEAR. THEY REQUIRE THE 3 PARTICIPANTS (#1,2,3) , THE FASTENER, THE HARDWARE, AND THE BODY, ARE ALL TO UP TO THE JOB. THE THINKING REGARDING SHEAR AS DESCRIBED BELOW COMES UP ALL THE TIME IN CONSTRUCTION WHEN FASTENERS ARE USED TO HANDLE LOADS.



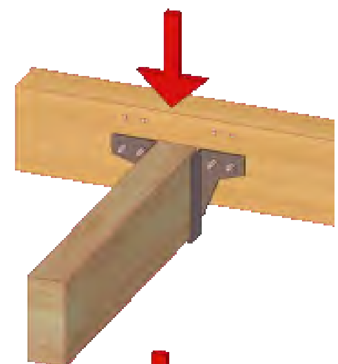
HEAVIER GUAGE HANGER WITH FEWER 'STRUCTURAL' SCREWS



LIGHTER GUAGE HANGER WITH LOTS OF NAILS

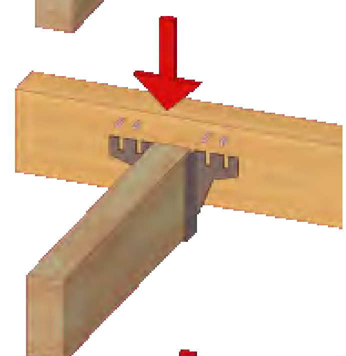
#1-THE FASTENERS

***BOLTS/LAGS/SCREWS/NAILS**_ARE THE CONNECTING METHOD. IN THIS APPLICATION THEY NEED ENOUGH SHEAR STRENGTH TO WITHSTAND THAT LOAD ON THE BEAM. ALL FASTENERS HAVE A SHEAR VALUE BASED ON STRENGTH OF THE STEEL AND CROSS SECTIONAL AREA OF (EACH) FASTENER RESULTING IN A TOTAL SHEAR VALUE. IF THE FASTENERS ARE NOT UP TO THE TASK THEY SHEAR AND ARE TORN APART AT THE FACE OF THE BEAM.



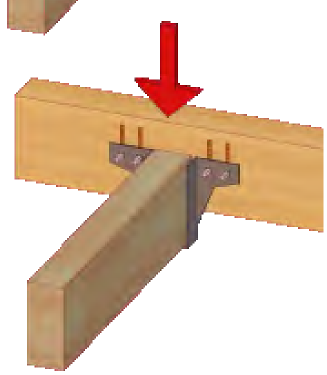
#2-THE MEDIUM

***THE HARDWARE**_IN THIS CASE IS THE STEEL HANGER. IT MUST BE DESIGNED TO RESIST TEARING OUT WHICH IS A SHEAR FAILURE. SO IT TOO HAS A UNIT SHEAR VALUE BASED ON THE STRENGTH OF THE STEEL AND THE AREA OF CONTACT BETWEEN THE FASTENER AND HARDWARE. A THIN GUAGE STEEL CAN TEAR.



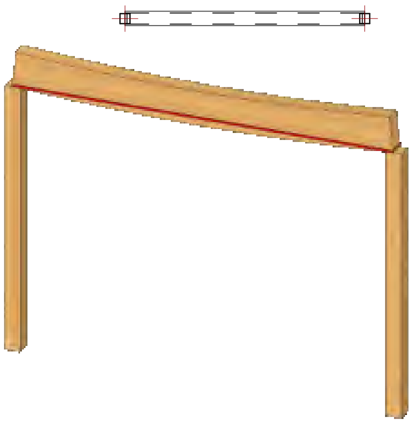
#3-THE BODY

***THE BEAM**_IN THIS CASE IS RECIEVING THE FASTENERS. ALSO DEALING WITH THE SAME SHEAR LOAD SO THE UNIT STRENGTH VALUE OF THE WOOD AND THE AREA OF WOOD IN CONTACT WITH EACH/ALL FASTENERS EQUALS THE RESISTANCE AVAILABLE IN THE BODY. IF THE WOOD IS NOT UP TO THE JOB THE FASTENERS WILL TEAR OUT OF THE WOOD.



HANGER SELECTIONS

*THE HANGER SELECTION CHART WILL INFORM THE NUMBER AND TYPE OF FASTENERS, CONSIDER THE STRENGTH AND GUAGE OF THE STEEL HANGER MATERIAL, AND CONSIDERS THE STRENGTH OF THE WOOD 'BODY'. THOSE 3 CONDITIONS ARE CONSIDERED AND A LOAD CAPACITY IS LISTED. THE CHARTS TAKE A LITTLE GETING USED TO.



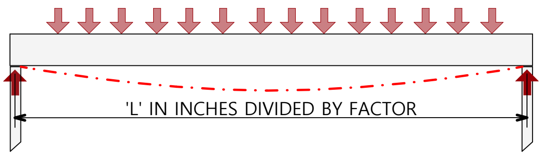
DEFLECTION LIMITS EXPLAINED(c5.5)

***FOR ALL SPANS_**ALL BEAMS WILL DEFLECT. WE CAN PICK HOW MUCH. DEFLECTION ITSELF IS NOT A FAILURE. WHEN A MEMBER DEFLECTS 'PAST ITS LIMTS' IT BECOMES A FAILURE IN BENDING (SEE BELOW).

***DEFLECTION CALCS_**ARE SIMPLE. L (LENGTH) /DIVIDED BY THE FACTOR = INCHES OF DEFLECTION. SO A 15' SPAN IS (15x12"=180") DIVIDED BY 240=.75". DIVIDED BY 360=.5". DIVIDED BY 480=.375". DIVIDED BY 600=.3". SO THE HIGHER THE DEFLECTION LIMIT THE LESS THE DEFLECTION.

***DEFLECTION PER CODE_**FLOOR JOISTS LIMITS ARE SET AT L/360. BEAMS ARE THE SAME EXCEPT FOR BEAM SPANS LONGER THAT 20' IN WHICH CASE THE DEFECTION IS LIMITED TO A MAX (1/2").

***PRACTICAL THINKING_**THERE ARE CERTAINLY CASES WHERE BEING MORE CONSERVATIVE THINKING WITH DEFLECTION IS SMART. THE QUESTION ASKED WHETHER THIS AMOUNT OF POSSIBLE MOVEMENT WILL CAUSE ANY PROBLEMS.

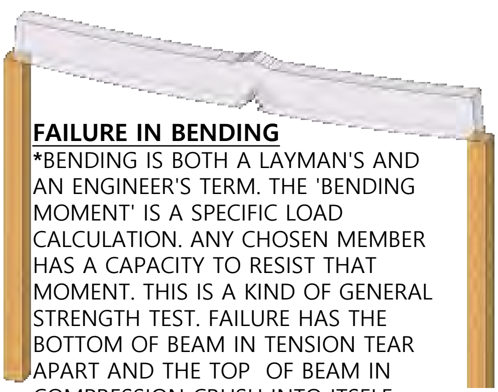


WORST CASE

*STRUCTURAL DESIGN OFTENS REQUIRES PRELIMINARY LAYOUTS THAT TRACK DOWN THE MOST DEMANDING STRUCTURAL CASE CONDITIONS. ADDRESSING THOSE EARLY CAN SOMETIMES SET THE STAGE FOR OTHER DECISIONS

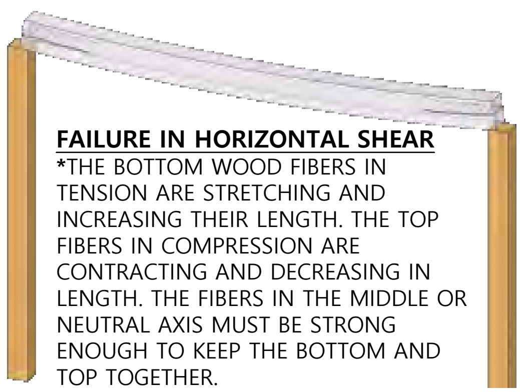
*ONE SIMPLE EXAMPLE IS FINDING THE DEEPEST JOIST AND BEAM REQUIRED TO ACCMOMPLISH THEIR RESPECTIVE JOBS WHICH CAN SET A MINIMUM FLOOR DEPTH. THAT MAY EFFECT ALL OTHER BEAM AND JOIST CHOICES.

*DEFLECTION LIMTS OFTEN DETERMINE THESE DEPTH REQUIREMENTS.



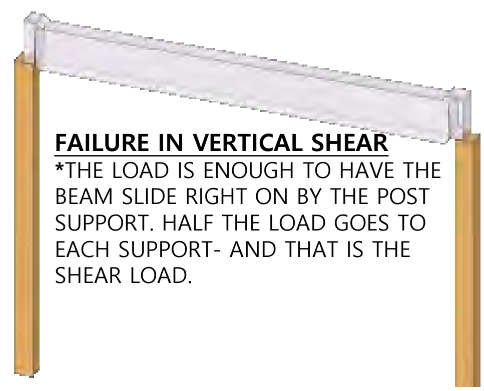
FAILURE IN BENDING

*BENDING IS BOTH A LAYMAN'S AND AN ENGINEER'S TERM. THE 'BENDING MOMENT' IS A SPECIFIC LOAD CALCULATION. ANY CHOSEN MEMBER HAS A CAPACITY TO RESIST THAT MOMENT. THIS IS A KIND OF GENERAL STRENGTH TEST. FAILURE HAS THE BOTTOM OF BEAM IN TENSION TEAR APART AND THE TOP OF BEAM IN COMPRESSION CRUSH INTO ITSELF.



FAILURE IN HORIZONTAL SHEAR

*THE BOTTOM WOOD FIBERS IN TENSION ARE STRETCHING AND INCREASING THEIR LENGTH. THE TOP FIBERS IN COMPRESSION ARE CONTRACTING AND DECREASING IN LENGTH. THE FIBERS IN THE MIDDLE OR NEUTRAL AXIS MUST BE STRONG ENOUGH TO KEEP THE BOTTOM AND TOP TOGETHER.



FAILURE IN VERTICAL SHEAR

*THE LOAD IS ENOUGH TO HAVE THE BEAM SLIDE RIGHT ON BY THE POST SUPPORT. HALF THE LOAD GOES TO EACH SUPPORT- AND THAT IS THE SHEAR LOAD.

THESE 'FAILURES'

***DESIGN CHECKS_**THESE 3 POTENTIAL FAILURE CONDITIONS ARE ALSO ROUTINELY CHECKED IN ANY BEAM DESIGN. A BEAM WILL PASS OR FAIL- BY SOME MARGIN. LIGHT WEIGHT RESIDENTIAL CONSTRUCTIONS THAT MARGIN WILL NOT ULTIMATELY MATTER. BUT THEY NEED TO GET A PASSING GRADE.

***BEAM 'MATERIAL' MATTERS_**THE VARIOUS BEAM CONSTRUCTIONS-AND THEIR SHAPES AND PROPORTIONS- RESPOND DIFFERENTLY TO THESE 3 TESTS. AND TO THE DEFLECTION AND 'BOUNCE' DESIGN CONCERN. IF THIS PRESENTATION WERE RESTRICTED TO DIMENSIONAL LUMBER AS THE MATERIAL, SOME SPECIFIC CHARACTERISTICS FOR BEHAVIOR IN THE CONTEXT OF THESE 'STRUCTURAL TESTS' WOULD BE REASONABLE. BUT THE ENGINEERED PRODUCTS, GLULAMS, STEEL ARE REALLY DIFFERENT PERFORMERS.

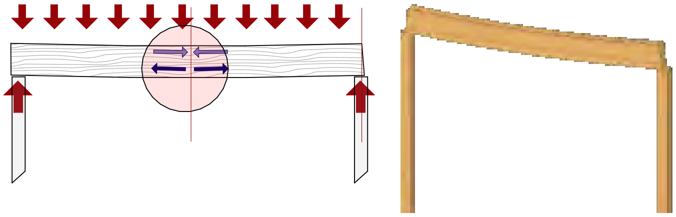
SPAN CHARTS OR ENGINEERING DESIGN

***REPETITIVE MEMBER SPAN CHARTS_**THESE ARE ALL RELIABLE. MEMBERS INDICATED AT THE RESPECTIVE SPANS HAVE PASSED ALL THE STANDARD CHECKS NOTED ABOVE. ONE RULE OF THUMB IN USING THEM IS TO RECOGNIZE THAT SPANS OVER -SAY 15'- ARE SUBJECT TO 'BOUNCE'. SO IF A STIFF FLOOR IS WANTED BE CAUTIOUS/CONSERVATIVE IN SELECTING BY CHOOSING A CLOSER SPACING OR A MEMBER SIZE GREATER THAN THE MINIMUM. THIS ISSUE HAS BEEN WELL RECOGNIZED IN THE ARENA OF ENGINEERED JOISTS (c5.5).

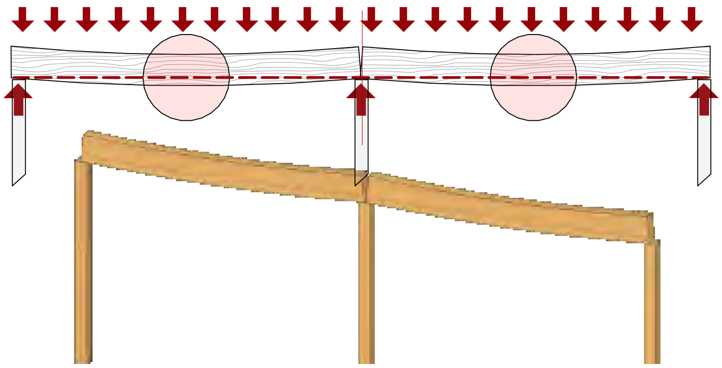
***BEAM AND GIRDER SPAN CHARTS_**THERE ARE SPAN CHARTS FOR GIRDERS AND HEADERS (TABLES 602.7). GIRDERS AND HEADERS ARE BOTH ABSOLTELY FUNCTIONING AS BEAMS SO THE CHART IS VALID. THE CHART TRIES TO OFFER A LOADING CONDITIONS, BUT IS RESTRICTED IN HOW ANY REAL CONDITIONS IT CAN INCORPORATE. ONE CAN DO SOME THOUGHTFUL INTERPOLATION- BUT THIS IS NOT A RECOMMENDED WAY TO DO THIS. THERE IS ALSO A SPAN CHART FOR DECK BEAMS IN APPENDIX M.

***BEAM 'ENGINEERED' DESIGN_**THE ADVANTAGE OF HAVING BEAMS ENGINEERED IS SEVERAL FOLD. BEAM TYPE, AND DEPTH BECOME A CHOICE THAT CAN BETTER INTEGRATE INTO A DESIGN CONDITION. OF COURSE ONE HAS TO HAVE IDENTIFIED THAT CONDITION. OFTEN BUILDING SUPPLY OPERATIONS HAVE A DESIGN/ENGINEERING SERVICE EQUIPPED TO HELP WITH PRODUCTS THEY SELL. TRUSS OPERATIONS ALL HAVE ENGINEERING SERVICES EITHER IN HOUSE OR INDEPENDENTS ON CALL, OR ONE CAN HIRE AN ENGINEERING SERVICE THAT IS NOT PRODUCT BIASED. KEEP IN MIND THAT BEAM SELECTION IS A SMALL PART OF THE ENTIRE LOAD TRACKING REQUIREMENT. LOGIC SAYS CORRECTLY THAT SIMPLE HOMES HAVE SIMPLER STRUCTURAL SITUATIONS AND CAN SIDE STEP ENGINEERING SERVICES IF ALL SITUATIONS ARE CODE ADDRESSED. MORE COMPLEX DESIGNS ARE NOT GOING TO HAVE ALL THESE CONCERNS ADDRESSED IN THE CODE.

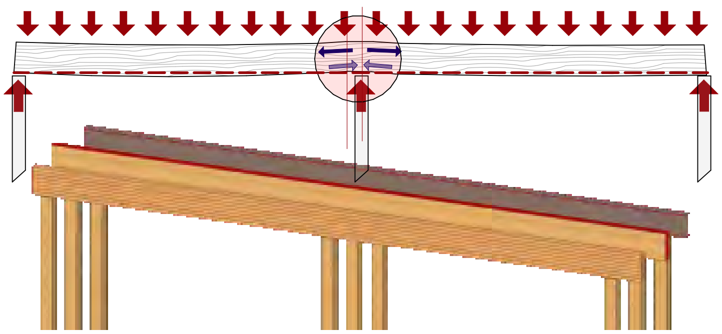
SINGLE SPANS, CONTINUOUS SPANS, CANTILEVERS, LOAD CASES



SIMPLE BEAM/SINGLE SPAN_THE MOST COMMON CONDITION. THE LOAD IS SPLIT- HALF GOING TO EACH POST. DEFLECTION AT MID SPAN ALWAYS WANTS CHECKING.



SIMPLE BEAM/MORE THAN ONE SPAN_THESE SPANS CAN LINE UP FOREVER. THE DISTINCTION IS THE LOAD ON THE CENTER POST IS DOUBLE THE LOAD ON THE END POST, AND BEARING AREA IS SHARED OVER THAT INTERNAL POST. DEFLECTION IS THE SAME AT MID SPAN.

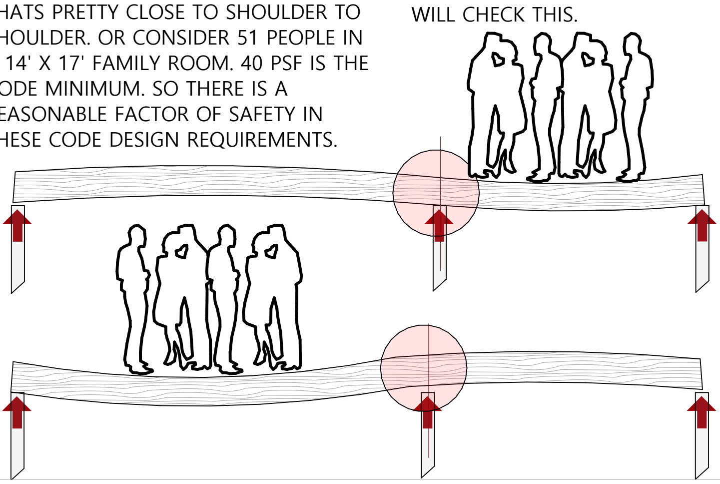


CONTINUOUS BEAM/MORE THAN ONE SPAN_POSTS CAN LINE UP WITH 1 BEAM MEMBER SITTING ON TOP. THE GLULAM, LVL, AND STEEL BEAM CAN BE HAD IN LONG LENGTHS. THE STRUCTURAL RESULT IS REDUCED DEFLECTION BETWEEN SUPPORTS. THE CAUTION IS THE INCREASED 'MOMENT' IN THE BEAM DIRECTLY ABOVE THE POST. THIS IS CHECKED IN BEAM DESIGN. USUALLY A SMALLER BEAM MEMBER (THAN IN THE SINGLE SPAN) WILL SUFFICE.

LIVE LOADS ARE LIVE

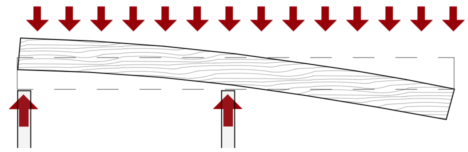
LIVE LOAD PEOPLE_THE BASE UNIFORM LIVE LOAD IS 40 PF. IF AN AVERAGE PERSON WEIGHS 185 IT TRANSLATES TO ALLOWING 1 PERSON EVERY 4.63 SQ FT WHICH IS AN AREA OF 2.15' X 2.15'. THATS PRETTY CLOSE TO SHOULDER TO SHOULDER. OR CONSIDER 51 PEOPLE IN A 14' X 17' FAMILY ROOM. 40 PSF IS THE CODE MINIMUM. SO THERE IS A REASONABLE FACTOR OF SAFETY IN THESE CODE DESIGN REQUIREMENTS.

LOAD CASES_THIS TERM IS AN ENGINEERING ONE, AND ADDRESSES THE LIVE LOAD BEING SHIFTED AROUND TO DIFFERENT PLACES ALONG THE SPANS OF JOISTS AND BEAMS. ENGINEERING SOFTWARE WILL CHECK THIS.

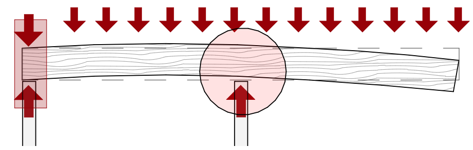


CANTILEVERS

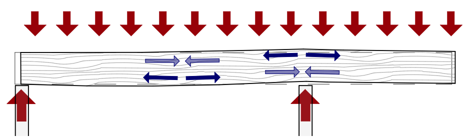
***GENERAL BEHAVIOR**_CANTILEVERS HAVE A LOT OF USES AND PRESENCE IN WOOD FRAME CONSTRUCTION. THE JOIST AND BEAMS TYPES NOTED THRU THIS CHAPTER ALL ARE CAPABLE- TO ONE EXTENT OR ANOTHER. THE EXCEPTION IS THE THE TRUSS WHICH MUST HAVE THE CANTILEVER 'DESIGNED' INTO IT.



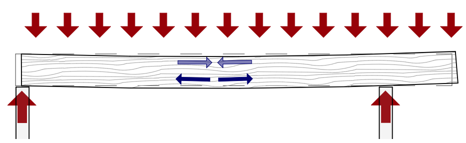
SEESAW_THE CANTILEVER HAS A SEESAW BASIC BEHAVIOR. THE FULCRUM POINT IS THAT SUPPORT ALONG THE BEAM SPAN WHOSE POSITION IS CRITICAL.



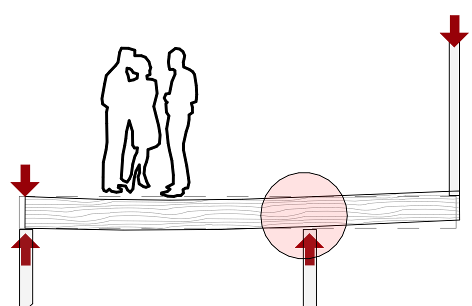
CAPTURE 1 END_IF ONE END IS HELD IN PLACE THERE IS NO SEESAW ACTION. HOLDING THAT END FROM WANTING TO LIFT UP, EITHER WITH A COUNTER WEIGHT (LOAD COMING DOWN) OR A CONNECTING PLATE ACHIEVES WHAT THE ENGINEER MIGHT CALL A PARTIALLY RESTRAINED BEAM. WITH THE LEFT END RESTRAINED THE CHALLENGE IS THE BEAM MOMENT OVER THE FULCRUM SUPPORT AND OR THE DEFLECTION ON THE FREE END.



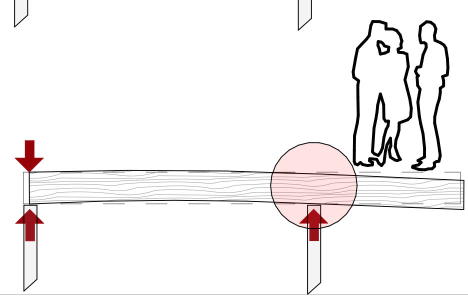
BALANCE_AN OVERHANG BEAM CAN GET INTO A COMFORTABLE BALANCE WHERE THE LOAD ON THE OVERHANG ACTUALLY BENEFITS THE MAIN SPAN BY WANTING TO LIFT/CONTAIN ITS DESIRE TO DEFLECT.



SMALL OVERHANG_2' OVERHANGS ARE GENERALLY ACCEPTED WITHOUT ENGINEERING CONFIRMATION. TYPICALLY A LITTLE 'UPLIFT' WILL EXIST ON THAT OVERHANGING END. CODE DOES HAVE GREATER PERMISSIONS CHARTED IN TABLES R503.33(1), R505.3.3(2)



LOAD ON THE END_SOMETIMES EXISTS AND SOMETIMES NOT IN A CANTILEVER SITUATION. IT OBVIOUSLY EFFECTS THE DESIGN



LOAD CASES_FOR THE CANTILVER ALSO MUST BE CHECKED. THEY CAN THROW A STRAIGHTAWAY CALCULATION OFF BECAUSE OF THE FULCRUM