ADVANCED FRAMING

THE ***ULTIMATE*** CONSTRUCTION METHOD FOR ***AFFORDABLE*** GREEN BUILDING

By Tony Mainsbridge

As an advocate of the **Green Building** concept, I am often amazed by the attitude of Builders, Designers, Engineers and Specifiers who continue to ignore the magnitude of **Advanced Framing Techniques** as one of the single most significant aspects of construction related **Environmental Responsibility**.

The ultimate paradigm of the **Advanced Framing Technique**, (*a.k.a*: **Optimum Value Engineering** or **O.V.E.**), encompasses the absolute definition of **Resource Efficiency** as an essential element of **Green Building** in the context of wood framed residential construction, as well as comprehensively enhancing both **Energy Efficiency** and ***Affordability***.

WOOD – RENEWABLE, SUSTAINABLE, USER FRIENDLY - OUR BEST RESOURCE

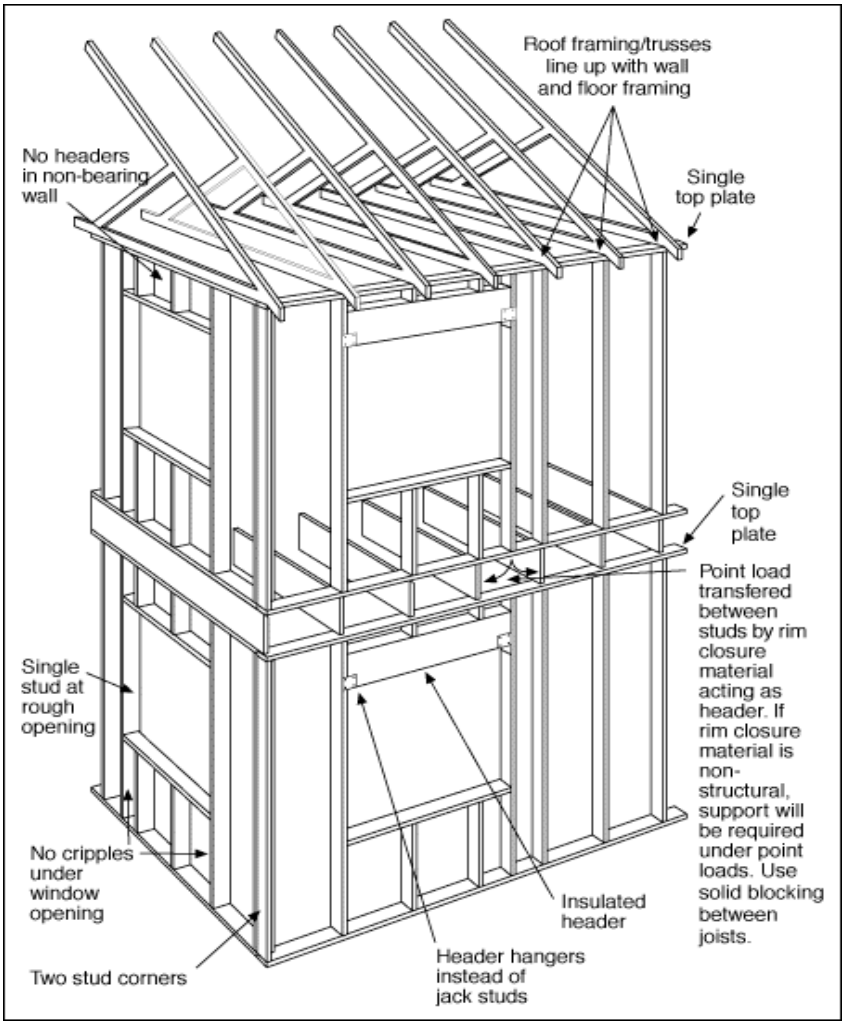
Dimension Lumber (2x4's, 2x6's, etc) and Wood Structural Panels (Plywood) are the most common materials used in the construction of all structural elements above the foundation of residential buildings up to three stories in height, and have been for generations.

The advent of both OSB (Oriented Strand Board) and EWP (Engineered Wood Products), with the focus of their design and manufacture on minimal use of wood fiber for optimum strength; have provided additional ways to build while conserving resources.

Building Materials manufactured from wood, a **Renewable** raw material, have a minimal impact on the environment, with exception to the fact that trees – the raw materials – serve a more momentous role in the realm of **Environmental Protection** and **Preservation**. **Trees**, as a living organism, **convert carbon dioxide** - one of the most abundant and pervasive **ozone depleting gases** - **to oxygen** through photosynthesis.

This **FACT** alone should make us all want to **conserve** as much **lumber** as possible!

THE FRAME – HOLDING THE HOUSE UP *AND* HOLDING THE HOUSE DOWN



The design loads of a structure include the DL (dead load) and LL (live load) which are the loads that must be held up, and the WL (wind load), both vertical and lateral, which are the loads that must be held down.

Dead Loads, sometimes referred to as Gravitational Loads or Compressional Loads, are typically defined and quantified as the mass (weight) of the materials used as the finishes applied to the structure (roofing, siding, drywall, floor coverings, etc); and the mass of the materials used for the support or fastening of these finishes (the frame).

Live Loads include the mass of such items as the occupants of, visitors to and movable furnishings within the structure, as well as the temporary loading of rain, snow and other weather related elements. The typical duration of weather related loads such as ice and snow are determining factors as to whether such loads must be defined as LL or DL and are normally related to the specific climate of the geographic location of the structure.

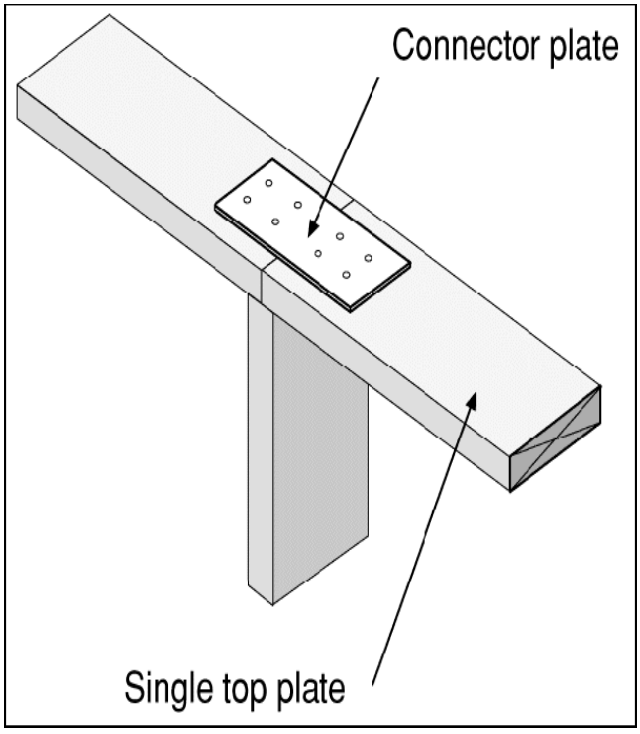
Wind Load is exactly as its name suggests – the load applied to the structure by the wind. Wind Load is the most variable - from calm to extreme; and dynamic – lateral (sideways), compressional (pushing down), and tensional (pulling up) against walls and roof.

ADVANED FRAMING TECHNIQUE – WHERE LESS TRULY EQUALS MORE

The premise of **Advanced Framing Techniques** is simple – to both support *and* restrain the design loads of the structure via a **direct load path** using the least amount of wood.

Advanced Framing is sometimes called **'In-line Framing'** or **'Stacked Framing'**, referring to the way each structural member is placed or stacked directly above the member below – generally with a maximum offset tolerance of one inch from the centerline of the lower member to the centerline of the upper member.

When the framing members are stacked, one directly above another, the end result is a "direct load path" where compressional and tensional loads are directly transferred through the framing members. This method provides not only a stronger structure, but also a less costly structure. Where framing members are not stacked in a direct line it is typical for the horizontal members to be of a larger cross-sectional size, or need to be multiple plies.

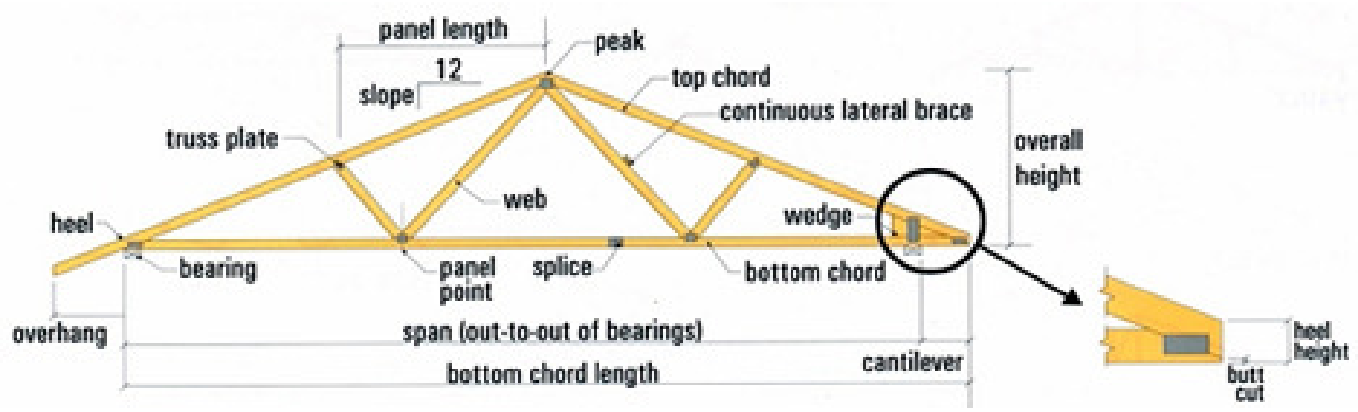


The most obvious example of **excessive lumber use** with **conventional framing** is the wall frames. Where walls are framed with studs spaced at **16"oc** and the roof is framed with rafters or **Roof Trusses** at **24"oc**, a **double top plate** is **required**. In areas that require hurricane straps to connect rafters to the top of the wall frames, **additional strapping** is typically required to anchor the **double top plates** of walls to the studs below where the rafters or **Roof Trusses** cannot be strapped directly to the studs – further **increasing** the **cost** of both **labor** and **materials** in this strapping process.

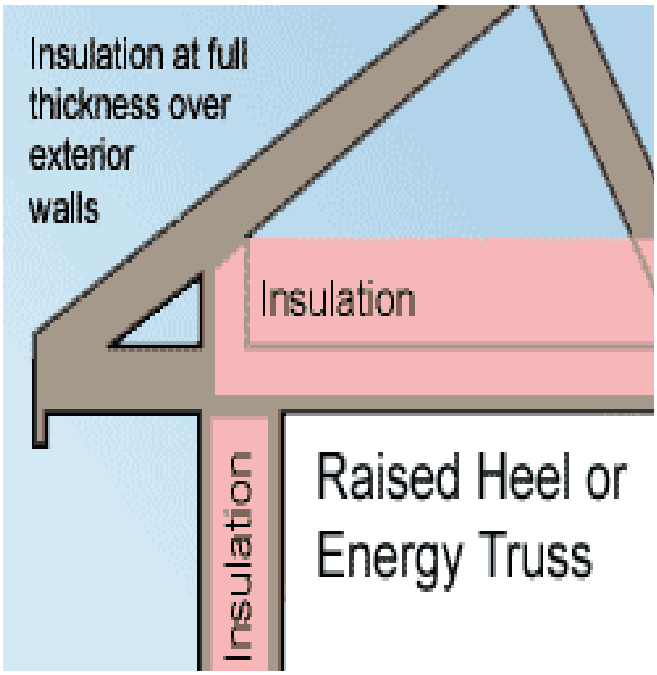
Where **Advanced Framing** is properly implemented, **stud spacing** is **24"oc**, **eliminating up to 33%** of the common studs, and, with only **single top plates**, will **reduce** both **material costs** and the **quantity** of dimension **lumber** used.

Dimension lumber use is **further reduced** in the wall framing by using **correct sizing** for headers and beams, as well as **'Junction Ladders'** at wall intersections in place of conventional **'T' junctions**. The **'T' junction** uses two studs with spacer blocking – a total of **19 lineal ft** of **lumber** for an eight foot wall height. A **Junction Ladder** uses horizontal blocking spaced at **24"oc** between the common studs using only **6 lineal ft** of **lumber**.

The best installation of the **Junction Ladder** is when the 2x4 Ladder Blocks are placed with the 3-1/2" face installed vertically. This practice provides for easier fastening of, and more backing to the drywall or other wall finish materials, as well as eliminating the **thermal bridge** that would occur in a 4" exterior wall. Provide blocking centered behind drywall edges.

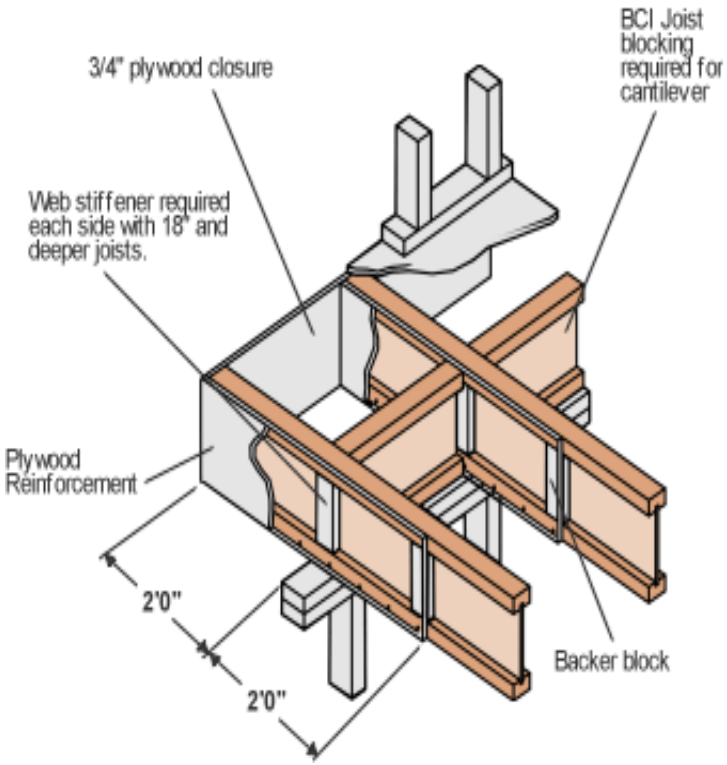


Truss Roof construction, in lieu of conventional rafters and ceiling joists, has always been a stronger, more **Resource Efficient** method of ceiling and roof construction. The strength gained with Roof Trusses is based on the plan specific Engineer Certified truss designs, as well as being purpose built, factory assembled, quality controlled structural components. **Roof Trusses** will typically reduce the volume of dimension lumber required to frame the ceiling and roof of a home, as well as **eliminate** the need for all/most **interior load-bearing walls**, in addition to **reducing** the job-site **labor** by around 30%.



The use of **'Cantilevered'** or **'Raised-Heel' Roof Trusses**, sometimes referred to as **'Energy Trusses'** can more easily and efficiently provide the vertical height necessary to **insulate** the ceiling to the full specified depth all the way to the outside of the exterior wall. The minimum vertical height needed is calculated as the insulation depth (R-30=10", R-38=12") plus a minimum of 1" where the attic is to be ventilated. Baffles are recommended to provide an unobstructed ventilation path under the roof decking.

Floor Framing design, for both crawl-space and multi-level construction, can reduce the total volume of dimension lumber required when the **spacing** of the joists is **maximized** relative to the span of the joists - even at the expense of increasing the size (depth) of the joists. In crawl-space construction, where 2x8 joists may be specified at **16"oc**, 2x10 joists at **24"oc** would use approx **16% less lumber** for the common joists. Multi-level homes benefit from the use of **Floor Trusses** or **I-Joists** at **24"oc** between floors to better accommodate plumbing drains and HVAC ducting.



On average, a home built with **Advanced Framing Techniques** will use around **25% less lumber** than the same home framed with **conventional/traditional methods**.

ENERGY EFFICIENT ADVANCED FRAMING – ***SERIOUSLY !***

Advanced Framing Techniques are an ***affordable*** approach to **Green Construction** through more than just **Resource Efficiency** and subsequent ***material cost reduction***.

Energy Efficiency has a measureable impact from **Advanced Framing** both directly to the home-owner, as well as indirectly - relative to the **reduction** of ***Embodied Energy*** within the milling (lumber), manufacturing (plywood), transportation of the raw materials, and delivery of Building Supplies to the construction site.

Embodied Energy is the energy consumed by, and contained within all products from the point of harvest/extraction of any/all resources and raw materials to the consumer. Since **Advanced Framing** uses about **25% less lumber**, a subsequent **reduction of demand** on structural **lumber** would mean a **reduction** of **25%** in the **energy consumed** to harvest and transport the logs; mill, process and kiln dry the lumber; transport the lumber products to market; and deliver the required materials to the construction site.

The direct **Energy Efficiency** gain to benefit the consumer is related to the **increased efficiency** of the **insulated envelope** of the home. **Advanced Framing** in the exterior wall construction **reduces** the **thermal bridging** – the **conduction** of **heat** and **cold** through the **structural members** from the **outside to** the **inside** of the **exterior wall**.

Infra-red image of **Thermal Bridging**

Independent research has shown that, although wood is a poor conductor of both heat and cold – especially in comparison to steel, it is a better thermal conductor than fiberglass batt or other insulation. The **resistance** to **thermal conduction** is referred to as the **'R-Value'**. An exterior wall framed with **2x4 studs** at **24"oc** has a '**whole-wall**' **R-Value 7.24% higher** than a wall framed with **2x4 studs** at **16"oc** due to the **reduced amount** of **lumber** as a **thermal bridge** and **increased insulated wall area**. In the case of a 6" wall, the **whole-wall R-Value** is **6.6% higher** at **24"oc** compared to **16"oc**.

Any **increase** in the **R-Value** of the exterior wall translates to **direct energy cost savings** based upon reduced heat gain (hot climate) and reduced heat loss (cold climate).

Wood framing is **far superior** to **Steel framing** in **whole-wall R-Value** and **thermal conduction**. The **thermal bridging of steel studs** for wall framing with R-13 fiberglass batt insulation shows a ***REDUCTION*** of **whole-wall R-Value** between **35.64%** (**4”** at **24”oc**) and **54.5%** (**6”** at **16”oc**).

Infra-red image of **Thermal Bridging**

COMBINED CAVITY AND FRAMED WALL VALUES

FRAMING	INSULATION	NOMINAL CAVITY R-VALUE	WOOD FRAME WHOLE-WALL R-VALUE		STEEL FRAME WHOLE-WALL R-VALUE
2x4 16" On Center	FIBERGLASS BATT	R-11	R- 9.16		R- 5.50
		R-13	R- 10.36		R- 5.98
		R-15	R- 11.47		R- 6.45
2x4 24" On Center	FIBERGLASS BATT	R-11	R- 9.70	+ 5.90%	R- 6.60
		R-13	R- 11.11	+ 7.24%	R- 7.15
		R-15	R- 12.44	+ 8.46%	R- 7.80
2x6 16" On Center	FIBERGLASS BATT	R-19	R- 15.45		R- 7.03
		R-21	R- 16.61		R- 7.35
2x6 24" On Center	FIBERGLASS BATT	R-19	R- 16.47	+ 6.60%	R- 8.55
		R-21	R- 17.86	+ 7.53%	R- 9.03

Tabulated values from www.foam-tech.com/theory/whole_wall_rvalue.htm

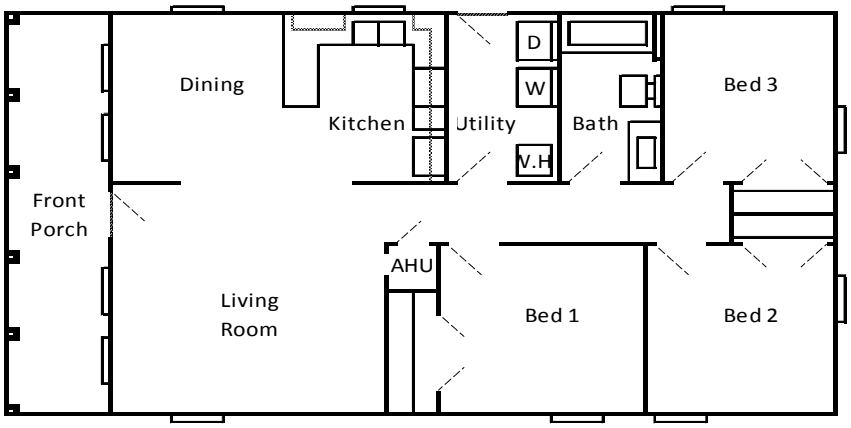
The percentage Increase Values represent the increase of Whole-Wall R-Value of **24”oc** Stud spacing compared to **16”oc** Stud spacing for both 4” and 6” wall thickness.

The US Department of Energy estimates an annual **Energy Cost Saving** of up to **5%** for Heating and Cooling when **Advanced Framing Techniques** are used.

COST EFFICIENT ADVANCED FRAMING – LESS DOLLAR$, MORE ENE

We all know that Green Building costs a whole lot more money – Right? – *WRONG!*

Advanced Framing Techniques are not just one of the best **Green Building** practices; **saving trees**, **reducing carbon emissions** from manufacturing and freight, **increasing** residential **Energy Efficiency**; they also **reduce** construction material **cost**.



The table on the following page is a comparison of calculated material quantities for both **Advanced Framing** and **Conventional Framing** of a very simple, 1092 sqft, 3 Bed, 1 Bath house with 8' ceilings, a 6' wide front porch and a simple 6/12 gable roof with 24" overhang. The home is **Engineered** to withstand **140mph winds** using **2x4 studs** at **24"oc** to the **exterior walls** (double studs & 12"oc at shear walls ends), built on a slab.

Conventional Framing assumes all interior and exterior openings to have **2-2x12 headers**, **16"oc** ceiling frame and **24"oc** rafters spacing. **Advanced Framing** uses **2x4** framing to **interior door headers**, **single 2x8 headers** to all load-bearing window and exterior door openings up to 3'6" wide, and **Roof Trusses** for the roof and ceiling frame. No quantities are figured for Exterior Wall Sheathing, Roof Decking, Sub-Fascia, etc, or any other materials where quantities and specifications would be identical. This is where the **Total Lumber Volume saved** would reduce **from around 33% to around 25%**.

The Case Study home is both small and simple. As **home** size **grows**, typically room sizes get larger – requiring wider dimension lumber for ceiling joists – further increasing the quantity of pieces and the volume of lumber. i.e: a 15' x 18' Living Room would need 13-14/ 2x8x16' (277.33 BdFt) Ceiling Joists (subject to layout); where as an 18' x 20' Living Room would need 15-16/ 2x10x20' (500 BdFt). **33% larger room** = ***80% more lumber!***

Location	Description	Quantity Regular	Quantity Advanced	Size	Length	Material	BdFt Regular	BdFt Advanced
Wall Frame	Sole Plates	21	21	2 X 4	14	#2 Trt S.Y.P.	196.00	196.00
Wall Frame	Sole Plates	1	1	2 X 6	18	#2 Trt S.Y.P.	18.00	18.00
Wall Frame	Top Plates	40	18	2 X 4	18	#2 S-P-F	480.00	216.00
Wall Frame	Top Plates	2	1	2 X 6	18	#2 S-P-F	36.00	18.00
Wall Frame	Studs	300	240	2 X 4	8	#2 S-P-F	1,600.00	1,280.00
Wall Frame	Studs	14	12	2 X 6	8	#2 S-P-F	112.00	96.00
Wall Frame	Junctions		5	2 X 4	18	#2 S-P-F		60.00
Wall Frame	Headers	14		2 X 12	14	#2 S.Y.P.	392.00	
Wall Frame	Headers		2	2 X 8	18	#2 S.Y.P.		48.00
Wall Frame	Headers		8	2 X 4	18	#2 S-P-F		96.00
Wall Frame	Window Base	8	5	2 X 4	18	#2 S-P-F	96.00	60.00
Wall Frame	Porch Beams	6		2 X 12	14	#2 S.Y.P.	168.00	
Wall Frame	Porch Beams		2	2 X 8	14	#2 S.Y.P.		37.33
Wall Frame	Porch Beams		5	2 X 4	18	#2 S-P-F		60.00
				Sub-Totals: Wall Framing			**3,098.00**	**2,185.33**
Ceiling Frame	Joists	12		2 X 8	16	#2 S.Y.P.	256.00	
Ceiling Frame	Joists	20		2 X 6	16	#2 S.Y.P.	320.00	
Ceiling Frame	Joists	10		2 X 6	14	#2 S.Y.P.	140.00	
Ceiling Frame	Joists	32		2 X 6	12	#2 S.Y.P.	384.00	
Ceiling Frame	Strongbacks	6		2 X 6	16	#2 S.Y.P.	96.00	
Ceiling Frame	Bracing	14	8	2 X 4	18	#2 S-P-F	168.00	96.00
Ceiling Frame	Deadwood	7	7	2 X 6	14	#2 S.Y.P.	98.00	98.00
Ceiling Frame	Deadwood	5	5	2 X 4	18	#2 S-P-F	60.00	60.00
Roof Frame	Rafters	50		2 X 6	18	#2 S.Y.P.	900.00	
Roof Frame	Ridge	3		2 X 8	18	#2 S.Y.P.	72.00	
Roof Frame	Bracing	6		2 X 6	16	#2 S.Y.P.	96.00	
Roof Frame	Bracing	8	6	2 X 4	18	#2 S-P-F	96.00	72.00
Roof Frame	Gable Studs	10		2 X 4	18	#2 S-P-F	120.00	
Roof Trusses	Top Chords		50	2 X 4	18	#2 S.Y.P.		600.00
Roof Trusses	Bottom Chords		25	2 X 4	16	#2 S.Y.P.		266.67
Roof Trusses	Bottom Chords		25	2 X 4	10	#2 S.Y.P.		166.67
Roof Trusses	Webs - Regular		50	2 X 4	12	#3 S.Y.P.		400.00
Roof Trusses	Gable Studs		6	2 X 4	12	#3 S.Y.P.		48.00
				Sub-Totals: Ceiling & Roof Framing			**2,806.00**	**1,807.33**
	TOTAL LUMBER VOLUME FOR CONVENTIONAL FRAMING						**5,904.00**	
	TOTAL LUMBER VOLUME FOR ADVANCED FRAMING							**3,992.67**
	TOTAL LUMBER VOLUME SAVING						**1,911.33**	**32.37%**

1911 BdFt represents a **Saving** of approx **14 Trees** (135+/- BdFt average yield of #2 Lumber per Pine tree) and about **$600** in **Lumber Cost Savings.**

ADVANCED FRAMING – LEADERS NEEDED, FOLLOWERS WANTED

For some, the most 'inconvenient truth' is that we still haven't arrived at 'the day after tomorrow'. Doom and gloom are what we deserve – the consequences for generations of ignorance, arrogance, greed and waste.

Histrionics aside; how much longer will we ignore the potential to build a better, cleaner, healthier world for ourselves, our children and our grandchildren – the most distant generation likely to call us to account?

Advanced Framing is **Stronger** (via direct load path); more **Resource Efficient**; more **Energy Efficient**; and more **Co$t Efficient**.

It should make sense that if a construction method is **better AND costs less** – every Builder would be using it. Unfortunately not all Builders and Carpenters are able to use this method. It is only the smarter Builders and Carpenters that can use **Advanced Framing Techniques** due to the need for greater foresight in the framing process. The Framing Carpenter must first layout the ceiling and roof frame on top of the wall frame single top plates in order to then mark the stud locations.

Some builders believe that **16"oc** stud walls are straighter …. *WHAT???* Builders who think like that are nowhere near smart enough to use **Advanced Framing Techniques**. Closer stud spacings cannot make the lumber straighter. If anything, where the straightness of a wall is expressed as the deviation from straight across three studs, **24"oc is straighter**. i.e: 1/8" deviation from straight over 48"(1/384) is straighter than 1/8" over 32"(1/256).

Other myths related to **Advanced Framing** include the belief that 1/2" Sheetrock would need to be replaced by 5/8" Sheetrock for the walls. This is true for ceiling framing at 24"oc where the Sheetrock is installed on a horizontal plane and extra stiffness is required, but no such requirement exists for wall installation – a vertical plane.

It is our responsibility, our duty to ourselves and to all future generations, to do what we can to utilize the resources of the current information age in order to arrest or reverse many of the negative side-effects of the industrial age, and to once-and-for-all embrace ***and*** execute a **'best practices'** approach toward the way we build.

Facts don't lie. **Advanced Framing Techniques** are the **Ultimate Construction Method** for ***Affordable*** **Green Building**.