How to Estimate the Cost of a Wood Framed Wall System

By Keith A. Dougherty, CPE

BIOGRAPHY

Keith A. Dougherty is the Senior Estimator for Estes Company, and a general contractor in Davenport, Iowa. He has worked as an estimator/ project manager and as a chief estimator for 12 years. He earned a Bachelors of Science in Construction Science from the University of Oklahoma in December of 1985.

He started in Williamsburg, Virginia with Henderson Inc. preparing competitive bid estimates for federal work at 12 military facilities throughout the Tidewater Virginia area. He proceeded to Dubuque, Iowa where he became Chief Estimator for Conlon Construction Co. There he oversaw competitive and negotiated projects locally, as well as in 18 states for a nationally known retail store chain.

INTRODUCTION

This paper shall address the cost of framing an exterior load bearing wood framed wall system. The components of this system will be shown using dimensional material, although pre-engineered wood products are available they will not be presented in this paper. While there are many types of wood framed wall systems, i.e. interior load or non-load bearing, balloon wall framing; I will focus on exterior load bearing systems.

A) MAIN CSI DIVISION -
Division Six (6) Carpentry

B) SUB-DIVISION -
Section 06050 Fasteners and Adhesives
Section 06100 Wood Framing
Section 06150 Sheathing
Section 06300 Wood Treatment

C) BRIEF DESCRIPTION -
Exterior load bearing wood framed all systems are found on many types of projects, most notably is the construction of residential housing throughout the country. Additionally many multiple housing facilities such as apartment and condominium complexes are erected utilizing wood framed structures. This paper is based upon using an exterior load bearing wood framed wall system for a multiple story housing facility. This wall system shall typically bear on a concrete slab-on-grade or foundation wall of either concrete or masonry.

TYPES AND METHODS OF MEASUREMENT

The wood materials utilized in this system are classified by species, dimensional size and length. Dimensional lumber is quantified and purchased in several ways. Material suppliers will buy and sell material by the thousand board foot (mbf). If requested material can be estimated by the lineal foot, square foot or piece. For the purpose of this paper and sample estimate quantities shown shall be per thousand board foot.

It is important to note that the length of material will affect the purchase price of the material. Due to the dwindling supply of long straight trees, the longer the piece required for the work the higher the purchase price for the material. Also, dimensional material is only available for purchase in even lengths. Sheet goods are typically purchased in their standard size, which is four feet wide by eight feet long. Materials can be purchased in non-standard sizes for additional cost, which must be weighed against the savings in labor costs. When estimating by thousand board foot the required sizes and lengths must be evaluated to assign the proper price for each material type.

Conversion factors for board foot estimating can be determined utilizing the following method. First multiply the estimated material length, in feet, by its depth, in inches, and by its cross section, in inches. Then divide by twelve inches to achieve the board footage. To calculate the thousand board foot requirement, summarize similar materials by size and length required and divide this total by one thousand feet to determine the total amount required. Sheet goods or plywood are also available per thousand square foot. Their quantity can be determined by taking the total surface area covered and dividing by one thousand feet to achieve this unit of measure.

Should a project be specified utilizing the metric measurement system, the following conversions will be required, as wood-framing material is currently only available in U.S. dimensions.

Metric Conversion

Linear Conversions	
1 centimeter	=0.394 inches
1 inch	=2.54 centimeters
1 foot	=3.048 decimeters
Square Conversions	
1 sq. centimeter	=0.155 sq. inch
1 sq. inch	=6.452 sq. centimeters
1 sq. foot	=9.2903 sq. decimeters

FACTORS TO CONSIDER FOR TAKE-OFF AND PRICING

After completing a thorough review of the contract documents, it is important to establish workflow patterns and material lay down areas. Storage of wood framing materials can require a substantial area for stockpiling. This must be properly evaluated at the time of bid since a discount may be offered for taking all the materials required at one time verses daily deliveries. Factors to be considered to see if the discount is justifiable are:

1. Will a satisfactory work flow pattern be established and maintained utilizing large material lay down areas?

2. Is there enough open area available to receive all or large portions of the materials?

3. Is the area suitable for storage or will a stone base be required to stabilize the area?

4. Will a security fence or individual be required to prevent theft?

5. Will labor increase substantially due to excessive material handling and storage yard cleanup?

6. Will additional equipment be required to handle material?

The above concerns are more critical when working on large multi-

unit facilities where large quantities of material will be required on a daily basis. Discussion with local suppliers will also assist in this decision process since they may not be able to properly supply a project on a daily basis. Smaller projects with less material requirements can typically be priced using a one time or periodic deliveries to accommodate project requirements.

Labor productivity should be evaluated for all jobs to establish the predicted productivity rates. Large, repetitious projects may have high productivity rates, while small one time or complex projects may require substantially lower productivity rates. This is due to the loss of the learning curve required to achieve higher production.

Knowledge of manpower and material availability are critical at the time of bidding. If either is in short supply they could substantially effect the overall completion date of a project as well as anticipated labor productivity rates. Again this is more critical on large projects than on small ones.

Geographical location of the project can also impact project completion and productivity. Projects located in the northern regions experience limited good weather construction seasons. During this tie labor availability will become a factor due to the limited season and need for many projects to be ongoing at one time. While projects are constructed during the bad weather months, additional expenses may be incurred due to reduced productivity, temporary enclosures or temporary heating that can be required. Another concern for non-seasonal construction is whether or not a finished slab will be installed to provide a proper work area for framing operations to occur. If a good working surface is not available it may be required that the wall sections be built off site in a controlled warehouse facility and transported to the site for field erection. This must be properly evaluated to determine lost productivity and quality on site verses the increased cost of transporting wall panels.

Projects located in the southern regions will experience longer or year round construction seasons and may be less impacted by labor availability. Certain southern regions will experience problems due to excessive heat which may reduce productivity or require shorter work days.

Additional factors to consider include: How accessible is the point of work for personnel and material? Will temporary access stairs, scaffolds or hoists be required? Will temporary material landing platforms be required due to reach restraints for equipment, building size or design constraints?

OVERVIEW OF LABOR, MATERIAL, EQUIPMENT AND MARK-UP

Upon completing the review of the contract documents and establishing work flow and material lay down areas the detailed takeoff can begin.

Exterior load bearing wood framed walls are typically erected on previously placed concrete slabs on grade or foundation walls. In some regions foundation walls are erected utilizing concrete masonry unit construction. Either version of the bearing surface can present problems and should be reviewed for items such as:

1) Steps in the wall which will vary wall framing heights.
2) Anchor bolt or other fastening method for attaching wall to foundation including spacing of such items.
3) Height of wall from adjacent grade which may require handrails for fall protection.
4) Requirements for finishing or leveling of foundation wall surface.
5) Number of corners in the wall system.

Where multi-story construction is utilized, exterior walls can be framed on top of lower level walls, ballooned framed or most commonly, directly onto the floor system erected on top of previously erected lower level walls.

Standard practice for wood wall construction is to assemble the wall into a panel on the surface provided and tilt up or raise the panel to stand where required. While this is an assembly process to construct panels each component must be looked at individually.

Wall framing begins with the layout of sill or sole plates and the first top plate. Layout will include locating and establishing anchor bolt patterns, stud framing spacing, wall corners, interior wall intersection points and locations of all openings to be framed into the wall system. In addition it is important to review what finish products will be attaching to the wall system in some instances additional studs or vertical blocking may be required and incorporated into the plate layout to meet finish product fastening requirements. Common practice is that sill plates or any framing material which come in contact with concrete, masonry or earth should be treated with a wood preservative treatment. As such, this item while taken off with the top plates will need to be priced separately. The sill plate will require additional attention as it may require drilling for previously placed anchor bolts or the installation of drilled expansion anchors to anchor the plate to the foundation. Local code may also dictate the use of a sill sealer to be installed under the sill plate. This material can range from a compressible foam to building felt. The required quantity can be derived from the sill plate lineal foot measurement and noted to be the same width as the dimensional framing required. Upon establishing the lineal footage for the plates and layout time required. This material can range from a compressible foam to building felt. The required quantity can be derived from the sill plate lineal foot measurement and noted to be the same width as the dimensional framing required. Upon establishing the lineal footage for the plates and layout time required it is time to proceed to the calculation of the studs required.

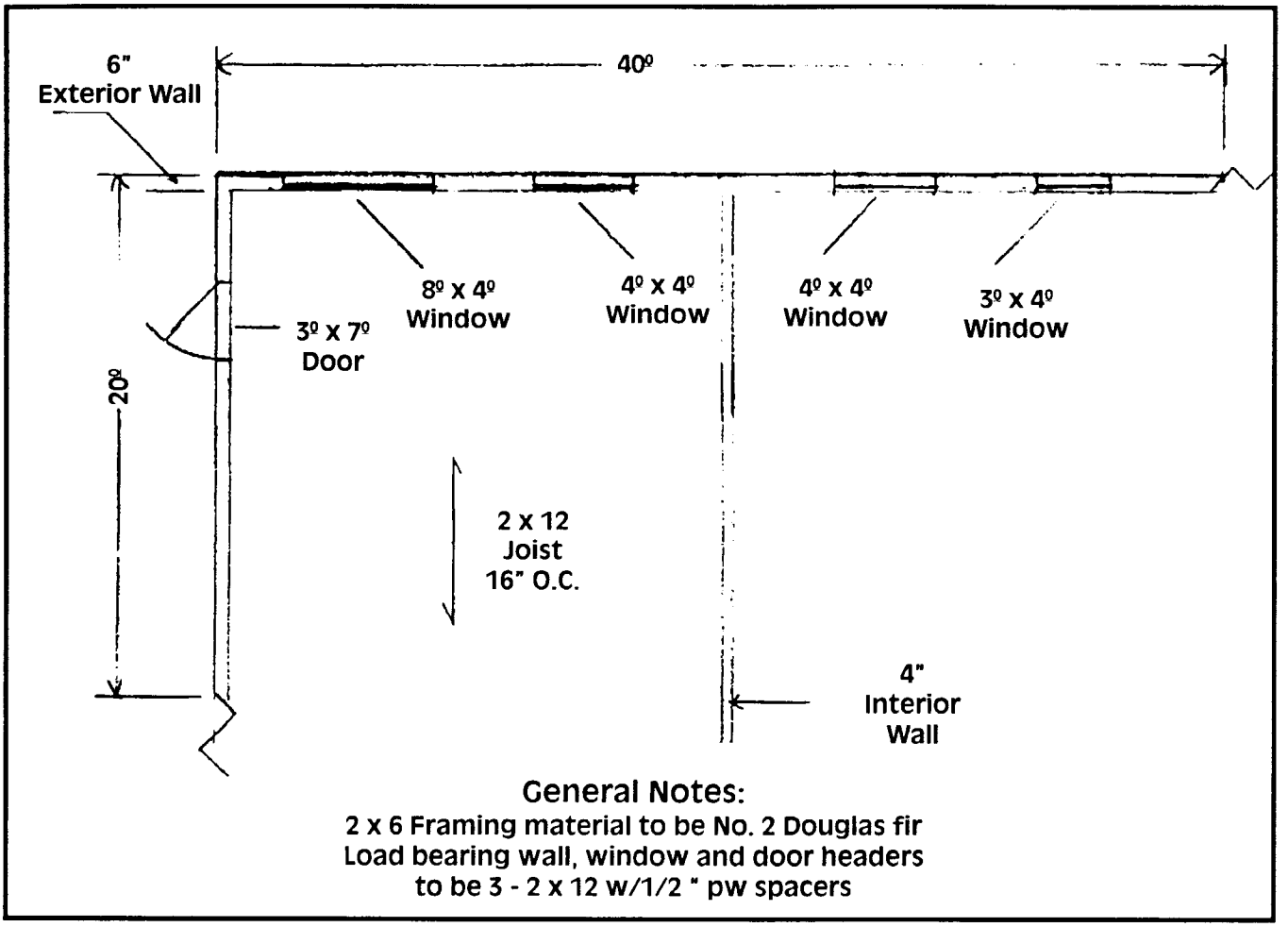
Stud spacing is established by the contract documents, industry standard is sixteen (16") inches on center. The quantity of studs required can be established by taking off the following two items.

1) Take the total lineal footage of wall to be framed and divide by the specified stud spacing, add one stud per measured wall to start the spacing sequence.
2) At each corner or intersecting wall location two additional studs must be provided to allow for proper anchoring of the adjoining wall system.

Adding these together and then multiplying them by the length of stud required rounded up to the nearest even foot dimension will provide the total lineal feet of studs required. If the wall height does not correspond to even material dimensions or to the use of pre-cut studs, the labor required to cut each stud to its needed length must be included.

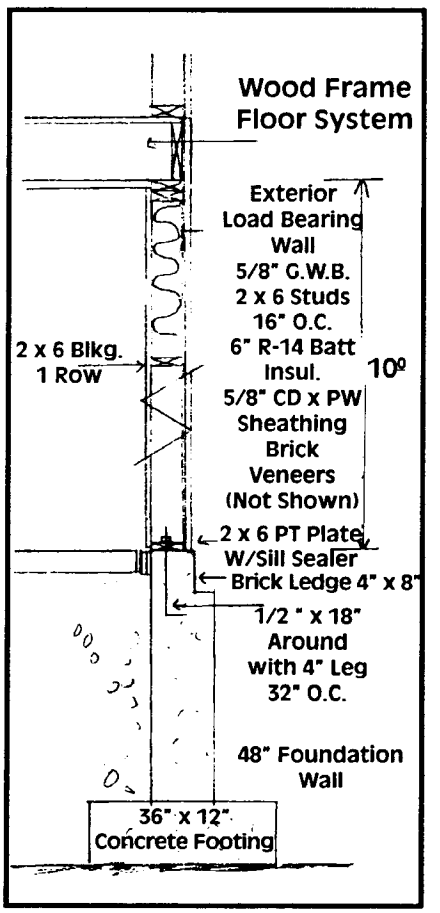
Additionally, labor productivity must account for the fact that each stud must be checked for warpage and crown and then individually placed on the slab for fastening to the sill plate to begin panel assembly.

The next component of the wall system is the development of all openings required. At each opening the studs previously counted must be



cut to length to fit below or above the framed opening. At window openings that do not reach the floor a rough sill must be added for the width of the opening. A header must be constructed to transfer structural loads across the opening to jack studs that are fastened to adjacent studs for load transfer. Most headers are job built from dimensional materials however some pre-engineered products are being utilized. Typical construction in a 2x6 load-bearing wall may be 3-2x12 members with plywood spacers between the 2x12 layers. A typical opening estimate will allow for header material, sheet goods spacers, 2 jack studs cut to length and a rough sill if required. Note, that the rough sill may not need to be estimated as a separate material item as it may be generated from the waste stud material that is cut to frame the opening. This labor should be accounted for since it is an extra installation item for the crew.

The next step is the installation of the first top plate, squaring of the wall section and installation of any horizontal wall blocking. Wall blocking quantities can be estimated by taking the total wall length and multiplying by the number of rows required. Numerous issues, i.e. code or design requirement, type of interior or exterior sheathing and direction being installed, can affect the number of rows, requirements for wall mounted accessories, all of which should be factored into the total quantity required. Some regions or design firms require the use of let in diagonal corner bracing. This item should be estimated at this time, as each stud affected will have to be notched to accommodate the bracing. One alternative is to use plywood sheathing at the corners that are surface applied to help reinforce and square the panel. The final step prior to panel erection is the installation of the exterior sheathing. This is calculated by multiplying the length of the wall, adjusted up to even foot dimension by the height of the wall, adjusted up to even foot dimension. These adjustments will allow the estimate to reflect actual purchase requirements for dimensional sheet goods. Two additional factors that must be evaluated are the removal of the sheathing at all openings and will installing the sheathing prior to panel erection increase the panel weight above where manpower alone can raise the wall. This second item is



critical, as it may require the use of equipment to erect the wall panel or delay the sheathing installation until after the panel is erected and require the use of scaffold or lifts to complete installation. For the wall panel erection additional material and labor will need to be estimated to provide for wind bracing and stabilizing of the wall panel. Upon erection of multiple wall panels the second top plate is installed to help tie the panels together and solidify the wall system. This items labor must be estimated separately as it is installed in the air and may require the use of ladders or scaffolds to reach, and as such, is much slower to install than plates that are installed while the panel is laying on the surface. Crew sizes will vary in size or quantity. On larger projects there could be three crews, one for layout, one for stud framing and one for sheathing. This multiple crew setup should allow for an increased learning curve and higher productivity for the project. Available equipment will also impact crew sizing. The use of air powered equipment for fastening and forklifts to move and stockpile material may reduce crew sizes needed.

Material mark-ups for waste will be required and will vary for each project. The estimator will need to monitor this factor throughout the estimating phase to determine if large quantities of cut materials will be left or will the project work to mostly even dimensions thereby reducing wasted materials. These factors can range from as little as three percent too as high as 15 percent.

Labor mark-ups may be required. Some factors that need to be considered would be: will the project require overtime, second or third shift work, weekend or holiday work. Each of these items will require separate adds to adequately cover the labor cost that could be incurred.

RISK CONSIDERATION

There are several risks that must be considered when estimating a project of this type. They include, pricing, manpower availability and the impact of OSHA requirements. Each item must be evaluated individually to establish their impact on the overall project.

The first risk in pricing of a wood framed wall system is the cost of the material itself. The lumber market is very volatile and susceptible to regional disasters causing instant shortages of material. As such, the time of year, length of time that the price quote is good for and current industry trends must be evaluated to properly price or mark-up material.

Another risk is the availability of manpower. Should the project occur in a area where construction is prospering, labor may be more expensive to hire or not available and so must be brought in from outside of the area. When labor is imported per diem expenses may need to be added to the labor cost.

The last risk is the requirement that the project be constructed in accordance with OSHA standards. Proper evaluation must be given to the need for fall protection, safety harnesses, guardrails, spotters or other personnel protection that may be required. These costs may be included in a projects general condition or in the appropriate subsection of the estimate.

While it can be difficult to predict the full impact of these risks, it is important that they be evaluated during the estimating process. The larger the scope of the job the greater the impact and more difficult the analysis will be.

RATIOS AND ANALYSIS

There are numerous reference materials available such as R.S. Means, Walkers, National Construction Estimator, that will cover nearly all wood wall framing systems. These reference materials can be used as a base guide in comparison to the final detailed estimate. It is important to remember that these are for reference only and do not reflect job site conditions, project requirements or local productivity factors.

In my experience large, complicated, multi-level construction have a cost split of 65% labor to 35% material. This is due to the excessive material handling and more complex configuration of these types of projects. While labor productivity is high, the labor content is also high due to the additional cutting and handling of the wall sections.

For projects, which are smaller and simpler in design, the cost is evenly split, in my experience. This can hold true even for multi-level construction, if the design is simple and allows for maximum labor efficiency.

Finally, another useful source of information is historical job cost and performance information. Accurate field tracking of previous projects will provide considerable insight to local productivity capabilities and crew sizing for future reference. Again this information must be interpolated between the projects.

MISCELLANEOUS PERTINENT INFORMATION

As with any scope of work in this industry there are additional items that are required to complete the work that cannot easily be quantified by completing a dimensional takeoff. Specific examples for wood wall framing are as follows: Nails, glue and miscellaneous fasteners can be calculated as a percentage of material or labor depending upon your company's preference. This percentage would not include any foundation or floor slab structural connectors as these items can be calculated as a percentage of material or labor depending upon your company's preference. This percentage would not include any foundation or floor slab structural connectors as these items can be quantified and individually are very expensive, and should be accounted for separately for both labor and material. The cost of small tools, i.e. skill saws, cut off saws, air guns, can also be calculated as a percentage of labor.

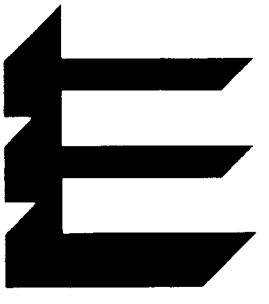
Non productive labor should also be included to cover material coordination and labor supervision. Additional labor may also be required for rough cleaning of waste material and banding and disposal of it. E

GLOSSARY OF TERMS

Ftg. - Footing
G.W.B. - Gypsum wall board
mbf - Thousand board foot
O.C. - On center
OSHA - Occupational Safety and Health Administration
P.T. - Preservative treatment
P.W. - Plywood

REFERENCES

1. **Carpentry**, Gasper Lewis, Delmar Publishers, 2nd edition, 1994
2. **1998 National Construction Estimator**, 46th edition, Martin D. Kiley and Benjamin G. Moselle, Craftsman Book Company, 1997
3. **Means Estimating Handbook**, Robert S. Means Company, Inc., 1995
4. **The Building Estimators Reference Book**, Frank R. Walker Co., 22nd edition



How to Estimate the Cost of a Wood Framed Wall System
Sample Estimate

Project	Sample Estimate													Date:	May, 1998
Job #	NA														
Location	NA													Estimator	
Architect	NA														
CSI	DESCRIPTION	L	W	H	Q	TOTAL QTY	UNIT	MAT'L UNIT COST	TOTAL MATERIAL	LBR PRODUCTION	RODUCTION UNI	TOTAL DAYS	LBR COST DAY	TOTAL LABOR	EQUIPMENT
06050	1/2" x 16" Anchor Bolts														
	Supply To Fdtn Contr														
	20' Wall Section, 32" O.C.					9	each	5	45.00						
	40' Wall Section, 32" O.C.					16	each	5	80.00						
06100	Sill Sealer					60	lnft	0.05	3.00	1200	lnft/carp/day	0.05	320.00	16	
06300	2x6 P.T. Sill Plate														
	60 lnft wall using 16' mat'l = 4 pcs	16			4	64	lnft								
	64 lnft x2"x6"/12"/1000 feet					0.064	mbf	750	48.00						
06100	2x6 First Top Plate					0.064	mbf	600	38.40						
	Labor To Layout & Install Plates					0.128	mbf			0.48	mbf/carp/day	0.27	320.00	86	
06100	2x6 Pre-Cut 10' Studs, 16" O.C.														
	20' Wall Section, 16" O.C.	10			16	160	lnft								
	40' Wall Section, 16" O.C.	10			31	310	lnft								
	Exterior Corner	10			2	20	lnft								
	Interior To Exterior Wall Intersectio	10			2	20	lnft								
	Door & Window Jack Studs	10		5	2	100	lnft								
	Sub Total Studs					610	lnft								
	610 lnft x2"x6"/12"/1000 feet					0.61	mbf	600	366.00	1.8	mbf/carp/day	0.38	320.00	122	
06100	2x6 Second Top Plate w/Scaffold					0.064	mbf	600	38.40	0.24	mbf/carp/day	0.27	320.00	86	25
06100	Door & Window Headers, 2x12														
	Door 3' Wide x 7' Tall	4	3		1	12	lnft								
	Window 6' Wide x 4' Tall	10	3		1	30	lnft								
	Window 4' Wide x 4' Tall	5	3		2	30	lnft								
	Window 3' Wide x 4' Tall	4	3		1	12	lnft								
						84	lnft								
	84 lnft x2"x12"/12"/1000 feet					0.168	mbf	850	142.80	0.5	mbf/carp/day	0.34	320.00	108	
06150	1/2" CDX PW Spacers @ Headers	4		1	2	8	sqft								
		10		1	2	20	sqft								
		5		1	4	20	sqft								
		4		1	2	8	sqft								
						56	sqft								
	Round Sqft Up To Even Sheets					64	sqft								
	64 sqft/1000 feet					0.064	mbf	450	28.80	0.512	mbf/carp/day	0.13	320.00	40	
06100	Labor To Cut Studs @ Openings					5	opngs			32	opngs/carp/day	0.16	320.00	50	
	Labor To Set Window Rough Sills					4	opngs			64	opngs/carp/day	0.06	320.00	20	
06100	2x6 Horiz. Blocking					64	lnft								
	64 lnft x2"x6"/12"/1000 feet					0.064	mbf	600	38.40	0.48	mbf/carp/day	0.13	320.00	43	
06150	5/8" CDX PW Sheathing	20		10	1	200	sqft								
		40		10	1	400	sqft								
						668.064	sqft								
	Round Sqft Up To Even Sheets					608	sqft								
	608 sqft/1000 feet					0.608	mbf	500	304.00	1.536	mbf/carp/day	0.40	320.00	127	
	Labor To Cut PW @ Openings					5	opngs			16	opngs/carp/day	0.31	320.00	100	
06100	Wall Panel Erection					2	each			8	each/crew/day	0.25	1,600.00	400	
	2x4 Wall Braces 8' O.C.	16			10	160	lnft								
	160 lnft x2"x6"/12"/1000 feet					0.16	mbf	550	88.00	1	mbf/carp/day	0.18	320.00	51	
06100	Non-Productive Foreman	4			1	4	hours			8	hour/carp/day	0.50	320.00	160	
	1 hour per day														
06100	Labor Haul Material	4			2	8	hours			8	hour/labor/day	1.00	280.00	280	
	2 hour per day														
06100	Labor Cleanup	4			1	4	hours			8	hour/labor/day	0.50	280.00	140	
	1 hour per day														
	Sub Total Material & Labor								$1,220.80					$1,827	$25
						Misc. Nails, Fastene		5.00%	$61.04			Small Tools	5.00%	$91.34	
						Sales Tax		5.00%	$61.04						
						Waste		5.00%	$61.04			Total Labor		$1,918.06	
						Total Material			$1,403.92			Total Material		$1,403.92	
												Total Equipment		$25.00	
												Total Cost		$3,346.98	
												Insurance	0.00%	$0.00	
												Margin	0.00%	$0.00	
												Total		$3,346.98	

Calendar of Events

July 1999
ASPE Annual Convention
Cleveland, Ohio
15th-17th
Wyndham Cleveland Hotel at Playhouse Square
Estimating Academy
Cleveland, Ohio
14th – 15th
Wyndham Cleveland Hotel at Playhouse Square

September 1999
Technical Boards Meetings
St. Louis, Missouri
17th – 19th
Murphy Company Offices

November 1999
Board of Trustee Meeting
Chicago, Illinois, 5th – 7th

HOTEL – TBD
Central Regional Meeting
Chicago, Illinois, 7th

HOTEL – TBD
JCMS Symposium
Chicago, Illinois
McCormick Place, 8th – 10th