HOW TO ESTIMATE THE COST OF STRUCTURAL REPAIRS TO LIGHT FRAME CONSTRUCTION REQUIRED DUE TO CATASTROPHIC EVENTS

CANDIDATE: PETER D. FOWLER

DATE WRITTEN: APRIL 30, 2000

SOCIETY OWNERSHIP PAGE

AUTHOR PAGE

Since beginning his career Mr. Fowler has experienced all sides of the light construction industry, having held positions including Laborer, Carpenter, Estimating Intern, Project Manager, General Contractor, Construction Consultant, Expert Witness, Vice President of Operations of a Construction Management and Consulting Company and now President of Pete Fowler Construction Services, Inc., a general construction, remodeling and construction management firm which was founded in 1995.

Peter D. Fowler holds a Bachelor of Science in Construction Management from California State University, Chico. In addition to being a published author and continuing contributor to the Journal of Light Construction, Mr. Fowler's computer and networking expertise allows a level of analysis and communication not frequently found in persons with similar levels of technical construction expertise.

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CANDIDATE NO. 0500075

DATE WRITTEN: APRIL 30, 2000

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1. Introduction

   a. Main CSI Division
   b. Specific Sub-Section; Code and Name
   c. Brief Description of the Subject Matter

1.a. Division 6 – Wood & Plastic

1.b. Subsection 06100 – Rough Carpentry

1.c. The following paper, HOW TO ESTIMATE THE COST OF STRUCTURAL REPAIRS TO LIGHT FRAME CONSTRUCTION REQUIRED DUE TO CATASTROPHIC EVENTS, will describe the details of estimating the rough carpentry (CSI 06100) aspects of a structure repair necessitated by a catastrophic event, such as an earthquake or hurricane.

The repairs in this Paper are particularly concerned with structures located in geographical areas deemed by local codes / municipal jurisdictions as prone to experiencing future events similar to those that caused the damage being repaired. Thus, cosmetic repairs will not suffice. The example used in this Paper is a wood frame structure receiving a code upgrade / structural retro-fit designed by a registered engineer.

2. Types and Methods of Measurement (including metric conversions)

The measurements involved in estimating for structural repairs required due to catastrophic events are similar to those for estimating the framing components of a residential remodel.

Unlike some new projects where framing materials might be purchased in bulk by the board-foot (BF), wood framing materials are specified by the lineal foot (LF) in the specific nominal dimensions required. It is sometimes wise, for the limitation of waste, to specify the lengths of material and a specific number of such boards, in lieu of a gross footage for each material size which might otherwise allow the supplier to determine board lengths.

Again in contrast to new projects, where the gross square footage (SF) of plywood might be calculated then divided by a typical 32 SF sheet size (4 feet by 8 feet) plus a nominal waste factor, a structural repair is likely to have waste factors that exceed new construction and thus it is more accurate to calculate the number of sheets required on a location-by-location basis. This is due to areas requiring the installation of plywood having sometimes-unusual configurations and the common specification that requires spliced sheets to be blocked at all plywood sheet edges.

Hardware components are critical to the activity of structure repair and each must be counted, especially in the case column caps, hold-downs, and heavy-duty structural straps. With some hardware, lineal footage (LF) quantity-take-off (QTO) can be made then converted to the each (EA) equivalent by dividing the number of LF by the number of components required per LF (EXAMPLE: A 25’ length requiring A35 @ 8” on-center = 25’ divided by (8/12) = 38 EA).

See Table A on the following page for a list of common components, their common measurements, the metric equivalent and the conversion factors to metric measures.

Table A [SECTION 2]

Item	Measurements	Metric Equivalent	Conversion Factor
Framing Members			
Posts, Studs, Plates, Beams, Joists & Blocking	Nominal dimensions in INCHES, length in LINEAL FEET (LF)	INCHES to Centimeters (CM) LF to Meters	INCHES x 2.5400 = CM LF x .3048 = Meters
Plywood	Thickness in fraction of INCHES, and number EA of 4'x8' (32 SF) sheets	INCHES to Centimeters (CM) SF to SQUARE METERS	INCHES x 2.5400 = CM SF x .0929 = SQUARE METERS
Hardware			
Hold-downs	Type (manufacturer specification), and number required EACH	Same	NA
Column caps	Type (manufacturer specification), and number required EACH	Sized based on framing material size. See Framing Members above.	Sized based on framing material size. See Framing Members above.
MST straps	Length in INCHES and quantity EACH (MST60 is 60" long)	INCHES to Centimeters (CM)	INCHES x 2.5400 = CM
Coil straps	Length in INCHES	INCHES to Centimeters (CM)	INCHES x 2.5400 = CM
Ram-set anchors	Diameter and length in INCHES, Type (manufacturer specification), and number required EACH	INCHES to Centimeters (CM)	INCHES x 2.5400 = CM
Anchor bolts	Diameter and length in INCHES, and number required EACH	INCHES to Centimeters (CM)	INCHES x 2.5400 = CM
Beam hangers	Size and Type (manufacturer specification), and number required EACH	Sized based on framing material size. See Framing Members above.	Sized based on framing material size. See Framing Members above.
Joist hangers	Size and Type (manufacturer specification), and number required EACH	Sized based on framing material size. See Framing Members above.	Sized based on framing material size. See Framing Members above.
A35 / A35F	EACH	Same	NA
Bolts (nuts & washers)	Diameter and length in INCHES, and number required EACH	INCHES to Centimeters (CM)	INCHES x 2.5400 = CM
Nails	Size in PENNY WEIGHT (which have dimensional equivalent charts in INCHES), Type and POUNDS (in standard weights for box sizes)	INCHES to Centimeters (CM) POUNDS to Kilogram (kg)	INCHES x 2.5400 = CM POUNDS to 0.4535924 = kg
Epoxy	Cartridges (containing 2 part mixture) EACH	Same	NA
Threaded rod	Diameter and length in INCHES	INCHES to Centimeters (CM)	INCHES x 2.5400 = CM
Other			
Deputy Inspector	Per HOUR or DAY	Same	NA
Labor	Man hours (MH) and crew hours (CH)	Same	NA

3. Factors to Consider re: Take-Off and Pricing

   a. Small vs. Large Quantities
   b. Geographic Location
   c. Seasonal Effect on Work

3.a. Repetitiveness of any given activity often leads to increased efficiency. As such, if a structure repair includes, for example, many similar hold-down installations then it is likely that the overall efficiency for those activities will be better than a project with many different configurations and assembly types. Gains in efficiency due to repetition of an assembly type should be applied to decrease the total labor cost for the given activity.

3.b. The geographic location is pertinent due to the fact that structure repairs due to catastrophic events, as defined herein, will likely be in areas prone to experiencing similar events in the future. In addition, the local construction techniques for dealing with catastrophic events such as earthquakes or hurricanes should be well established and the local work force should be familiar with these repair techniques. Unfortunately, subsequent to major catastrophe, a large workforce that is not indigenous may need to be employed. This temporary workforce might not be familiar with local building techniques and this may cause a loss in efficiency and an increased need for supervision to maintain adherence to the repair design. The estimate should reflect the labor availability, and the experience of the workforce used in the repairs.

3.c. The seasonal effect on work is dependent on the extent of the structure repair. If the roofing and exterior wall covering requires removal then the seasonal effect is quite significant and should be considered due to the requirements to protect the existing work and any building contents not removed prior to beginning construction. If the weatherproofing components require only limited removal then the seasonal impact can be small. For some repairs, it is possible that a very limited amount of exterior work will be required, including little damage to the plantings / landscaping surrounding the structure. In these cases, even rain or snow days might not significantly impact the estimate and project costs. The impact is best judged on a project-by-project basis by a skilled and experienced estimator. It is sometimes wise for the estimator to coordinate these estimate sections with project personnel who might be even more familiar with the day-to-day rigors of dealing with seasonal or weather-induced losses in efficiency.

4. Overview of:

   a. Labor
   b. Material
   c. Equipment
   d. Indirect Costs and
   e. Approach to Mark-Ups

Introduction to Section 4 – This section and it's subsections will outline the organization of the estimate as well as recommend plan review, quantity-take-off (QTO) and pricing procedures for the construction cost categories.

The estimate should be organized, as much as is practicable and efficient, so that it is easy for field personnel to understand the scope of the project and the methods of construction envisioned by the estimator (see Section 7 for further discussion). Begin with a complete, cursory review of the plans to gain an idea of the scope and magnitude of the project at hand. Some aspects of the estimate might require knowledge of the site, so a site visit or panoramic photographs are helpful.

Once the QTO begins the estimator should be careful to review all General and Structural Notes for items that impact project costs such as specific manufacturer specifications, framing material grade requirements or special inspections. Then move to the Foundation Plan for repair or verification call-outs including foundation repairs, foundation augmentation, HDs, anchor bolts, structural posts, or references to structural details for complex assemblies. These locations can be highlighted on the plan set and documented on QTO sheets. See section 9 for a sample QTO sheet.

Move to the Framing Plan(s) (First Floor Framing, Second Floor Framing, Roof Framing, etc…) to perform QTO on shear walls, special structural installations or assemblies, framing repair specifications, hardware call-outs, etc… Again, these details can be highlighted on the plan set and should be clearly documented on QTO sheets, with references to the location in the plan set from where they came.

Once the QTO is complete the estimator will have a solid understanding of the scope of repair and is ready to forward the items to the detailed estimate / pricing sheets for a stick-by-stick break down of the Labor, Material, Equipment and Other costs directly associated with the repair. See Section 9 for a sample pricing sheet.

4.a. Labor – Knowledge of the crews that will be performing the structure repair work is very important for reducing a significant risk factor and is discussed further in Section 5. The categories of work that might be required in a structure repair include:

- Installing new hold-downs (HD)
- Installing new framing members including Posts, Studs, Plates, Beams, Joists and Blocking
- Installing new Plywood shear walls
- Verifying shear walls
- Installing new framing hardware including, column caps, MST straps, coil straps, ram-set anchors, anchor bolts, beam hangers, joist hangers, A35 / A35F, etc.

Each of the above bulleted points has a number of work activities associated with the installation; an exhaustive break-down of each is beyond the scope of this paper but the following is an example of the activities that might be required for the installation of a new hold-down (HD):

- Protect adjacent surfaces
- Remove gypsum wallboard (GWB)
- Remove stucco (STCO)
- Drill for threaded rod (THRD rod)
- Install THRD rod w/ epoxy – supervised by Special (Deputy) Inspection
- Install HD5A at THRD rod w/ 2 EA bolts, nuts & washers
- Replace STCO
- Replace GWB

In pricing labor, the estimator must possess (1.) experience and understanding of the activities that make up the work to be performed and (2.) accurate crew costs that include total labor burden, which can include, but are not limited to: Health Care, Vacation, Education, FICA, Federal Unemployment, FUTA, SDI, State Unemployment, Workman’s Compensation, Vehicle and Liability Insurance. The work activities described in the previous paragraph are for the installation of an HD; a similar breakdown should be made for all activities defined during the QTO phase of the estimate. Once the list of necessary activities is made, the time required to perform the activities can be estimated and priced with burdened crew costs.

4.b. Material – As mentioned above, the estimate should begin with a structured take-off of the repair plans to note and highlight the materials and construction assemblies specified by the designer. All plan sets will be compiled differently depending on the nature of the repair, the designer, the draftsperson, etc., but a thorough take-off of all new, repaired and verified structural components will be necessary. Often the foundation plan will have the HD call-outs, the first and second-floor framing plan should note the shear wall locations, and the roof framing plan will show the hardware installations in the attic space.

The material call-outs by the designer will indicate the assemblies required and will thus drive the LABOR, EQUIPMENT and OTHER estimate needs. As mentioned above, the quantities in a structure repair are often best taken off on a piece-by-piece (stick-by-stick) basis. Most structure repairs are so unique that attempts at estimating factors such as cost per square foot, or price per HD are too dangerous for use by a conservative estimator. Materials that might be seen in a QTO (quantity take off) are listed in Table A [Section 2].

It is critical that material costs used in the estimate are adequately “burdened”. For the detailed estimate / “pricing” phase, I recommend using costs that include tax, delivery and any other applicable costs associated with materials or their delivery to the project site in preparation for use as envisioned by the estimator’s list of activities for any given construction assembly.

4.c. Equipment – Costs for equipment in light frame structure repair are sometimes limited to the “small tools and equipment” category. If a large number of HDs are being installed the use of roto-hammers and bits might be significant. Most of the equipment requirements can be foreseen from a review of the material QTO. Installation of light framing and associated hardware will not drive the need for major equipment needs.

Some structure repairs, for example hillside or other buildings, might require deep caisson foundations and require special equipment for deep drilling or excavation with limited access. In such a case access to the site is a critical factor in determining the type and size of equipment to be utilized.

Like material pricing, estimators need to be careful to be sure that ALL costs associated with equipment utilization be considered, not the least of which are taxes, delivery and pick up, or amortized costs for equipment owned by the company.

4.d. Indirect Costs – In the course of preparing for and completing the work on a structure repair indirect costs can include:

- General Conditions
- Contractor's Overhead & Profit
- Insurance & Bond
- Construction Management
- Architecture
- Engineering
- Testing & Inspection
- Permits & Fees
- Relocation
- Contingency on Direct Costs as well as Other Project Costs

4.e. Approach to Mark-Ups – Structural repairs due to catastrophic events are inherently fraught with risk, some of which are discussed in Section 5 below. Thus, if a contractor bears this greater than usual risk with a firm (bid) price, the contractor should include contingency figures as a hedge against the unknown. Ultimately, if the project goes as planned and the contingencies do not arise, then that cushion becomes extra job profitability in trade for increased risk. If however, the Owner bears the burden of the risk with a time and material contract then the fees should be in line with industry standards for relatively low-risk operations by one’s own forces and/or subcontract labor.

5. Special Risk Considerations

As mentioned briefly above, structural repairs due to catastrophic events are inherently fraught with risk. Plans are often filled with structural call-outs that were in the original design, but have not been verified by field or invasive inspection. The plans may call for field verification of the originally designed and specified components, in addition to the installation of any code-upgrade or new components or assemblies. This field verification is a primary source of risk in repairs of this nature. Conscientious original builders will leave behind a structure in need of very little repair based on the original design; not all builders are conscientious and some leave a large number of assemblies in need of remediation.

Another common source of risk is unknown availability, effectiveness and efficiency of the labor force. Catastrophe often over-burdens a skilled labor market and if an estimator is not sure of the crews that will be installing the planned work, then some added margin for low efficiency needs to be considered. I mentioned the importance of crew knowledge in Section 4 above, but its importance can not be over-emphasized.

Special or Deputy Inspection requirements can be costly and are often required for HD installations using epoxy to set the anchor into the foundation (as opposed to embedded in the foundation concrete during original construction).

Some municipalities require the repair designer to observe and authorize the work to proceed at certain points in the construction process. After catastrophic events, municipal inspectors can be *very* busy and delays in on-site visits postponed as a result. Any of the noted inspection issues can easily become a factor in cost over-runs with an inexperienced crew or poorly planned operations.

Material availability and timely delivery immediately following a catastrophe can be impacted. Not only can materials become difficult to procure at such times; the costs could increase substantially based on this unusual supply-demand situation.

Incremental delays and cost over-runs due to the abnormality of doing business in the aftermath of a catastrophe can add up to a significant project total and any aspect of the project should be scrutinized in this light.

6. Ratios and Analysis (Tools Used To Test The Final Bid)

In work that is as unique as repairs to light frame structures, use of ratios can be more dangerous or meaningless than when used in more predictable construction. Costs per square foot, per HD, per SF of shear wall or other factors are also, in this estimator's opinion, inherently risky due to the uniqueness of projects. Cost comparisons by factors such as those just mentioned can be helpful in checking for the validity of the over-all estimate *IF* the estimator has first-hand or reliable information to compare the complexity of projects. If factors such as these are to be used then reliable historical cost data must be available and compared to the current project being estimated. An evaluation of the project's complexity, size, location, access and other factors, must be made by the estimator as a point of reference to the project estimate at hand.

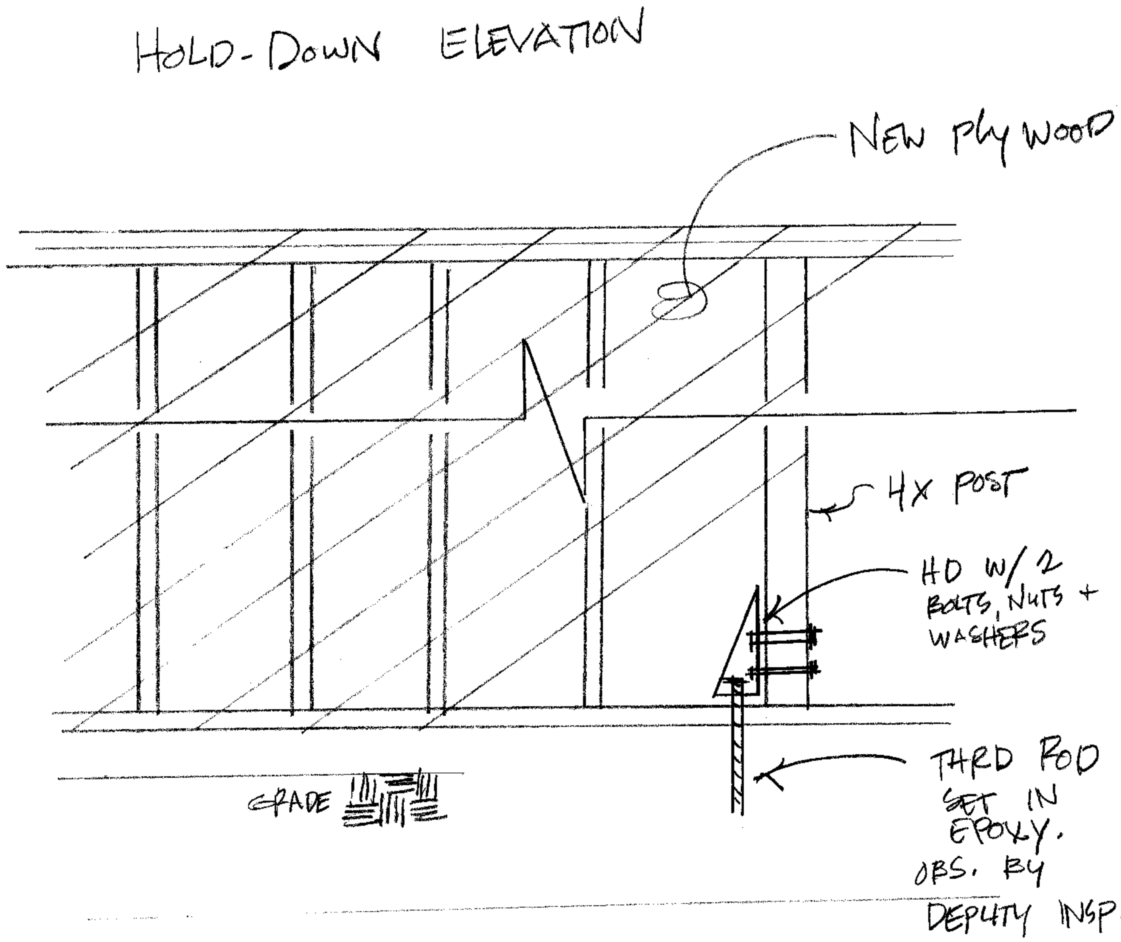
One analysis tool I find helpful is to make a grand total of labor / crew hours from the discrete activities that were estimated on a per-assembly or other basis. I then compare those to the anticipated time-line and crew utilization on a project wide basis.

7. Miscellaneous Pertinent Information

As in estimating new construction, making sure to not over look a significant aspect of the repair or re-construction is critical.

As mentioned in Section 4, the estimate should be organized, as much as is practicable and efficient, so that it is easy for field personnel to understand the scope of the project and the methods of construction envisioned by the estimator. Crews and time estimates for their utilization should be clear. Material lists should be easily generated. Any equipment costs and durations for its use should be clearly delineated. Other peculiarities or project costs foreseen by the estimator should come to the attention of the project manager or superintendent so that he/she does not have to reinvent the project analysis from scratch. The knowledge gained in development of the project estimate should be documented and passed to the field for effective implementation of the work. When this is done effectively, the filed professionals can give feedback to the estimator as to where his estimates were on-target and where they were not. This continuous improvement loop makes for effectiveness increases on all sides of the organization(s).

8. Sample Sketch



9. Sample Take-Off and Pricing Sheets

1 QTO Page

1 Sample Detailed Estimate Sheet

John Doe Residence
Quantity Take Off Sheet

					Dimensions					1	2	3	4	5	6
Line	Sheet	CSI	Description	Notes / Ref.	L / D	W	H	Total	Units	HRDWR	LF	CY	SY	SF	
1															
2	S2	06-100	HD2A	see D-4/SD1				1	ea	1					
3			HD5A	see D-4/SD1				29	ea	29					
4			HD6A	see D-4/SD1				3	ea	3					
5			HD7A	see D-4/SD1				3	ea	3					
6															
7	S2	06-100	2x4 Post		10'			22	ea		220.00				
8			4x4 Post		10'			2	ea		20.00				
9			4x6 Post		10'			2	ea		20.00				
10			6x6 Post		10'			20	ea		200.00				
11															
12	S2	06-100	Shear wall to foundation (steel plates)	D-2/SD2		3.5'	10'	1	ea					35.00	
13															
14	S2	06-100	Shear wall to foundation (steel plates)	D-4/SD2		4'	10'	1	ea					40.00	
15															
16	S3	06-100	Verify shear wall D	@ Exterior (see D-6/SD1)		8'	10'	23	ea					80.00	
17			Verify shear wall D	@ Interior		9'	10'	4	ea					90.00	
18			Verify shear wall E	@ Interior		6'	10'	1	ea					60.00	
19															
20	S3	06-100	New shear wall D												
21			D1	@ Exterior (see D-1/SD1, D-6/SD1)		4'	10'	1	ea					40.00	
22			D2	@ Exterior (see D-1/SD1, D-6/SD1)		6'	10'	1	ea					60.00	
23			D3	@ Interior (see D-2/SD2)		13.5'	10'	1	ea					135.00	
24			D4	@ Interior (see D-2/SD2)		19.5'	10'	1	ea					195.00	
25			D5	@ Interior (see D-2/SD2)		8.0'	10'	1	ea					80.00	
26			D6	@ Interior (see D-2/SD2)		4.5'	10'	1	ea					45.00	
27															
28	S3	06-100	New shear wall G	@ Interior (see D-2/SD2)											
29			G1	@ Interior (see D-2/SD2)		14'	10'	1	ea					140.00	
30			G2	@ Interior (see D-2/SD2)		7'	10'	1	ea					70.00	
31			G3	@ Interior (see D-2/SD2)		9'	10'	1	ea					90.00	
32			G4	@ Interior (see D-2/SD2)		8.5'	10'	1	ea					85.00	
33			G5	@ Interior (see D-2/SD2)		4.5'	10'	1	ea					45.00	
34			G6	@ Interior (see D-2/SD2)		4.5'	10'	1	ea					45.00	
35			G7	@ Interior (see D-2/SD2)		9'	10'	1	ea					90.00	
36			G8	@ Interior (see D-2/SD2)		7'	10'	1	ea					70.00	
37			G9	@ Interior (see D-2/SD2)		7'	10'	1	ea					70.00	
38			G10	@ Interior (see D-2/SD2)		11'	10'	1	ea					110.00	

John Doe Residence
Detailed Estimate

								Unit Cost				Total Cost				LINE
Line	CSI	Description	Notes / Ref.	Qty	Unit	Crew	Hrs	Labor	Material	Other	Subc.	Labor	Material	Other	Subc.	TOTAL
1												-	-	-	-	-
2		Work activities for each HD installed	RC4 @ $80.27/hr									-	-	-	-	-
3		Protect adjacent surfaces		1	ea	RC4	0.2	16.05	5.00			16	5	-	-	21
4		Remove GWB		1	ea	RC4	0.5	40.14				40	-	-	-	40
5		Remove STCO		1	ea	RC4	0.5	40.14		2.50		40	-	3	-	43
6		Install new FRMG	see elsewhere	0	ea	RC4		0.00				-	-	-	-	-
7		Drill for THRD Rod @ HD		1	ea	RC4	0.4	32.11		5.00		32	-	5	-	37
8		Install THRD Rod w/ special inspector	O=Epoxy	1	ea	RC4	0.5	40.14	0.00	8.39	50.00	40	-	8	50	99
9		Install HD w/ 2 ea bolts, nuts & washers		1	ea	RC4	0.5	40.14	0.00			40	-	-	-	40
10		Install PLYWD (where necessary)	see elsewhere	0	ea			0.00				-	-	-	-	-
11		Replace STCO (lath, scratch & brown)	see elsewhere	0	ea			0.00	0.00			-	-	-	-	-
12		Replace GWB	see elsewhere	0	ea			0.00	0.00			-	-	-	-	-
13		Clean-up		1	ea	RC4	0.4	32.11				32	-	-	-	32
14		**Total**										-	-	-	-	**312**
15												-	-	-	-	-
16	06-100	Hold Downs - see Detail 4/SD1														
17		HD2A	O=Total @ 14 ABV	1	ea				15.37	311.70		-	15	312	-	327
18		HD5A	O=Total @ 14 ABV	29	ea				22.94	311.70		-	665	9,039	-	9,705
19		HD6A	O=Total @ 14 ABV	3	ea				25.82	311.70		-	77	935	-	1,013
20		HD7A	O=Total @ 14 ABV	3	ea				26.81	311.70		-	80	935	-	1,016
21												-	-	-	-	-
22	06-100	Work activities per Post from SHT S2	RC2 @ $28.78									-	-	-	-	-
23		Protect adjacent surfaces	see elsewhere	1	ea	RC2	0.2	16.05	5.00			16	5	-	-	21
24		Remove GWB	see elsewhere	1	ea			0.00				-	-	-	-	-
25		Remove STCO	see elsewhere	1	ea			0.00		0.00		-	-	-	-	-
26		Demo EXTG FRMG as necessary		1	ls	RC2	0.5	14.39	0.00				-		-	
27		Install new FRMG		1	ea	RC2	1.0	28.78	2.00			29	2	-	-	31
28		Replace STCO (lath, scratch & brown)	see elsewhere	0	ea			0.00	0.00			-	-	-	-	-
29		Replace GWB	see elsewhere	0	ea			0.00	0.00			-	-	-	-	-
30		Clean-up		1	ea	RC2	0.3	8.63				9	-	-	-	9
31		**Total**										-	-	-	-	**60**
32												-	-	-	-	-
33	06-100	All Posts										-	-	-	-	-
34		2x4 Post	O=Total @ 31 ABV	22	ea				4.95	60.47		-	109	1,330	-	1,439
35		4x4 Post	O=Total @ 31 ABV	2	ea				9.86	60.47		-	20	121	-	141
36		4x6 Post	O=Total @ 31 ABV	2	ea				15.79	60.47		-	32	121	-	153
37		6x6 Post	O=Total @ 31 ABV	20	ea				38.50	60.47		-	770	1,209	-	1,979
38												-	-	-	-	-
39												-	-	-	-	-
40												-	-	-	-	-

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10. Glossary

Term / Abbreviation	Definition
A35	Small hardware component by Simpson Co. installed to transfer loads. The component has a 90 degree bend to accommodate attachment of framing not in a flat plane with one another (such as top plates to truss blocking).
Anchor Bolt	Fixes bottom plates to foundation; Imbedded in concrete; intended to resist shear forces.
Beam Hanger	Hardware designed to support the attachment of a beam to perpendicular structural members.
BF	Board Foot. Nominal dimension = 1” thick and 12” square.
Burden	Costs above base prices such as taxes, insurance, overhead, supervision, design, contingency, etc…
Catastrophic Event	For purposes herein, earthquakes, hurricanes and the like.
Column Cap	Hardware designed to support the attachment of a beam to a column.
CSI	Construction Specifications Institute
Deputy Inspector	Or Special Inspector. Private inspector required for specific installations of critical building components.
EA	Each
Epoxy	For purposes herein, 2 part mix to set THRD Rod @ HDs into the foundation.
GWB	Gypsum Wallboard. Drywall.
HD	Hold-down - Hardware often used to fix framing to foundation. HD is bolted to framing and an anchor embedded in the foundation; used to resist forces of uplift.
Joist Hanger	Hardware designed to support the attachment of a joist to perpendicular structural members.
LF	Lineal Footage or Lineal Feet
MH	Man Hour(s)
MST	A heavy-duty strap. See strap.
OC	On-center
QTO	Quantity-Take-Off
SF	Square Foot or Square Feet
Shear Wall	Construction assembly used to resist lateral forces; usually plywood applied over stud framing with HDs @ ends of wall.
STCO	Stucco; exterior lath & plaster.
Strap	Structural component used to maintain structural continuity across multiple framing members.
THRD ROD	Threaded Rod. Steel rod threaded to accept a nut.

11. References

   a. Copy of Letter Indicating Approved Topic
      (Electronically Scanned Facsimile)

American Society of
Professional Estimators

CERTIFICATION BOARD

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REPLY TO:

February 21, 2000

Peter D. Fowler
Pete Fowler Const. Services
27052 Paseo Activo
San Juan Capistrano CA 92675

I agree to the selected topic below and will prepare my technical paper according to the format outlined in the Certification Program Guide.

Candidate Number: **0500075**

Technical Paper Topic:

How to Estimate the Cost of Structural Repairs to Light Frame Construction Required Due to Catastrophic Events

Your Preferred Test Date (as recorded):

__X__ May 2000 - Local Chapter

________ July 2000 – Seattle, Washington

________ November 2000 - Local Chapter

Your Primary Discipline (as recorded) is: 1.4

Signature: Peter D. Fowler **Chapter:** ORANGE COUNTY CALIFORNIA

Date: 3/11/00

Please return this form to the SBO by no later than March 31, 2000.