Gene Farach, PE
Senior Project Engineer

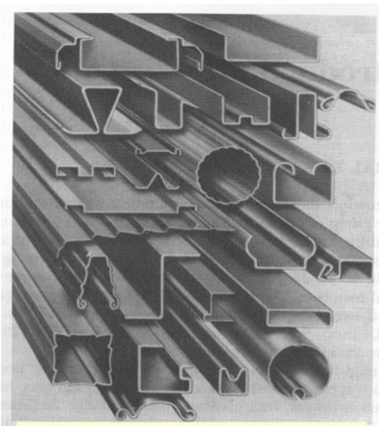
"Light-Gauge Engineering – A Proposed Service to the Industry"

The following is a review of the current market issues and the opportunities of marketing theses services. Sample Light-Gauge projects are presented for general understanding of the information needed in the utilization of this material.

An analysis is presented comparing wood studs and Light-Gauge metal studs. A sample connection design has been included to illustrate the process.

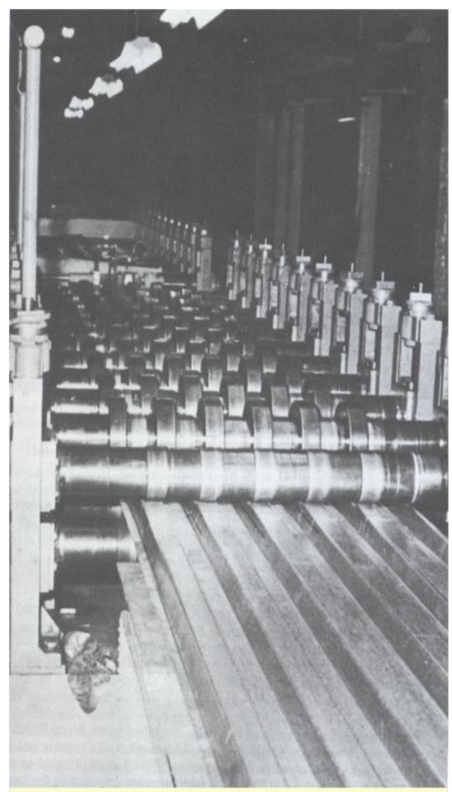
Fasteners, welding and available market accessories are also reviewed and lastly a look at history to bring us into perspective and to contemplate where we should go.

COLD-FORMED STEEL STRUCTURES - A brief history



Typical Cold Formed Sections...

The Steel Industry presently uses two main families of structural members. One is the familiar group of "hot-rolled" shapes such as "wide flanges", "steel angles", "steel channels", etc. and built-up steel members, composed of welded steel plates forming various shapes such as "plate girders", bridge "box girders", etc. The other group, less familiar but of growing popularity, is composed of sections cold-formed from steel sheets, strips, plates or flat bars in roll-forming machines or by press brake or bending brake operations. Steel plates and bars as thick as 1 inch can be cold-formed successfully into structural shape members; these are the cold formed steel structural members. Common thicknesses of steel sheets or strips, generally used in cold formed steel structural members vary from 0.0149" (28 gauge) to 0.2391" (3 gauge). In today's Industry "Light-Gauge" has become an accepted term when addressing the use of structural cold-formed shaped members from steel sheets in the thickness range of 0.0359" (20 gauge) to 0.1046" (12 gauge) or simply thinner than 1/8".



Cold Forming Steel Deck Section...

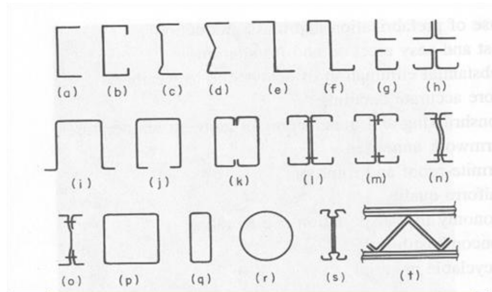
"Light-Gauge" steel members have been used in buildings since about 1850 in both the United States and Great Britain. In 1940 its popularity grew. Then in 1946, there was a remarkable acceleration in the U.S. in the use of thin walled "Light-Gauge" structural construction. At this time the American Iron and Steel Institute issued various publications controlling construction design codes such as the "Specification for the Design of Cold-Formed Steel Structural Members". Research conducted at Cornell University under the direction of George Winter since 1939, sponsored by the American Iron and Steel Institute, was largely responsible for the content of these early codes and specifications.

Since those early beginnings cold-formed members have been shaped into corrugated steel, tubes, channels, "C" studs, "Z" members, ribbed panels, and cellular floor panels. These shapes have been used in wall structures, floor and roof construction, three dimensional space frames, roof folded-plates, welded laminated hyperbolic paraboloid steel roof decks and arched roofs. These shapes were also used for total building structural design such as super bay airplane hangars, and up to four story buildings. They were even used for self framing, frameless stressed-skin cold-formed corrugated steel panels. Tests conducted in 1955 in the State of Nevada proved cold-formed members' very special structural quality as an effective blast-resistant structure.

The 1960's in both the United States and Canada witnessed the development of pre-engineered standardized "Light-Gauge" buildings. In the United States this design was largely based on the "Low Rise Building System Manual" issued by the Metal Building Manufacturers Association. In Canada the design, fabrication and erection of these steel building systems were based on the Canadian Sheet

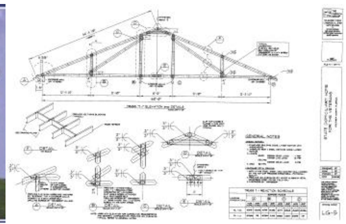
Steel Building Institute. Then in the 1970's the Department of Housing and Urban Development under the Operation Breakthrough Program, contracted with Republic Steel Corporation to develop a modular system for housing. This modular system consisted of "Light-Gauge" steel facing panels with an insulated core.

The past four decades have seen an explosion in the use of "Light-Gauge" metal framing. Every major Industrial or Commercial building uses cold-formed steel as an entity or as a component of its structure; such as canopies, trusses, curtain wall systems, to name few. The Cold-Formed Steel Design Manual of 2001 reflects our age of technology with provisions for welding, torsional design, plastic design, connection design and computer flow charts for the programming user. The new code mirrors the sophistication of our technological advancement in this very specialized field. Indeed, cold-formed steel systems have come a long way from its early beginnings.



Typical Cold Formed Profiles…

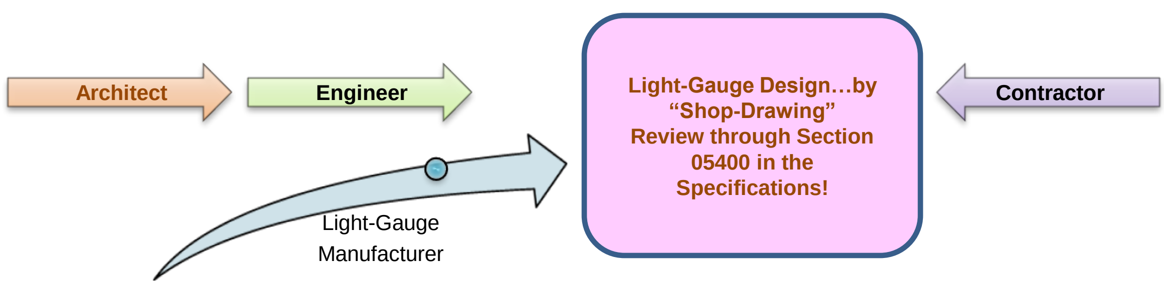
Gene Farach, PE
Senior Project Engineer



LIGHT-GAUGE METAL FRAMING IN TODAY'S MARKET PLACE

The Problems

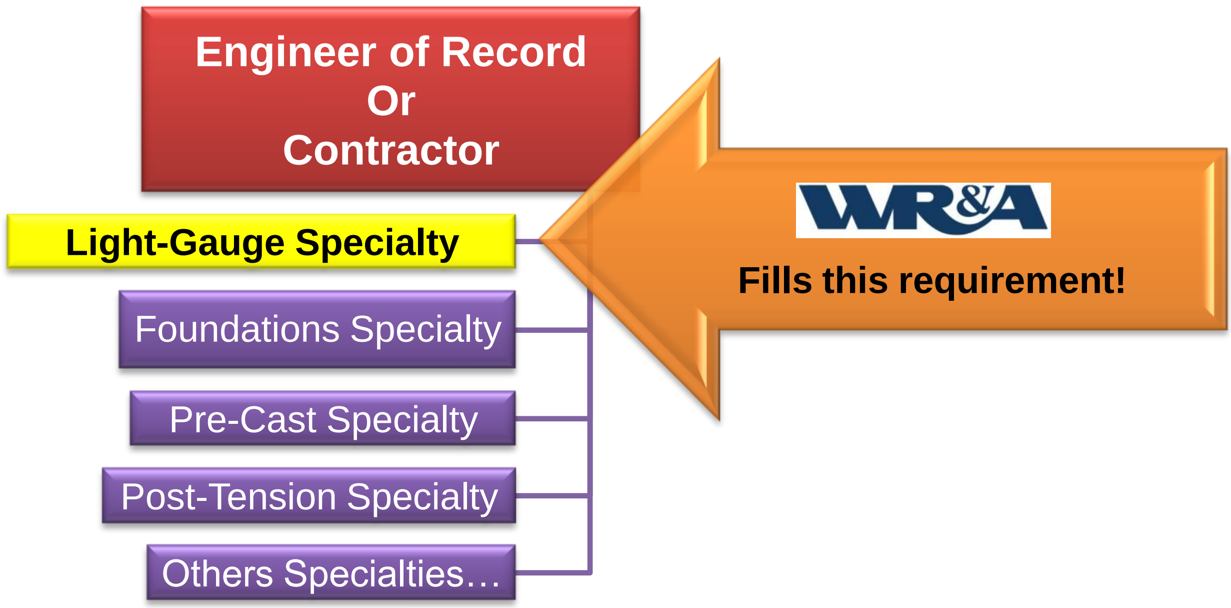
In a building project, the architect has traditionally been the design team's leader and manager. His responsibility to the owner is to assemble the design team, establish the general space usage and layout of the project identifying architectural features and with the help of the engineer, establish systems, materials and methods of construction; all of these activities accompanied by budgeting and general supervision through the bidding and construction phases. For the "Light-Gauge" metal framing design the architect rarely looks to the structural engineer for consultation; instead, he looks to the manufacturer for guidance. Most manufacturers provide the architect with "design charts” and "technical assistance". However, rarely does this technical assistance culminate in the production of formal "Light-Gauge" design documents sufficiently detailed for the bidding process. The architect specifies the use of "Light-Gauge" metal framing in his design documents and for the most part, the use of this system stems from the need to secure fire-rated assemblies conforming to fire tests conducted by UL and incorporated into building code requirements. It is in the architect's general project specifications, section 05400 where the contractor is instructed to provide for review light-gauge metal framing "shop-drawings", signed and sealed by a registered professional engineer. The architect's drawings reflect the extent of Light-Gauge metal framing work. His general notes identify the use of this framing material “... per manufacturer's recommendations". Thus, the projects extent of “Light-Gauge” design and construction relies on “shop-drawings review” prepared by others for its ultimate structural integrity, as shown below graphically.



The Opportunities – Light-Gauge Specialty Engineer

The current process for design and construction of the “Light-Gauge” portions of building projects provides for many basic engineering flaws culminating mostly in serious structural problems easily avoided. Conflicts and lack of coordination in the design process by fragmenting the responsibility for the different components of construction lead to law suits and costly rework. The industry can benefit if the “Specialty Light-Gauge Engineer” can render expert services in this area centralizing the point of design and joining the design team. This service to the industry can be a unique business opportunity for WR&A.

The proposal to offer Light-Gauge engineering services will fill the need by either pairing with the Engineer of Record or the Contractor, as other Specialties already do in an accepted fashion. This relationship will not be a conflict of interest nor will there be an appreciable feeling of competitiveness, but rather a team effort to produce the best design for the project.



What the Specialty Engineer does…

"Light-Gauge Manufacturers…"

Light-Gauge Manufacturers and General Information about the "C" Stud which is employed in most of the structural designs…

Manufacturers….

- ✓ Cemco
- ✓ Unimast
- ✓ AllSteel
- ✓ AMICO
- ✓ Dale
- ✓ Dietrich Industries
- ✓ AMICO/MAS
- ✓ Clark
- ✓ Bostwick
- ✓ Incor

Not all studs are created equal…

There is a disproportion in the manufacturing of Light-Gauge elements. Each has its own unique physical properties which demands a more careful design specification to insure the assumed strength…

600CS14P	6	1-5/8	L = 3.250	0.0747	14	2.199	0.736	3.758	1.253	0.241	0.487	3.579	1.123	0.186	33,614	-1.092	0.001370	1.7893	2.574	0.820
600CS16P				0.0598	16	1.827	0.595	3.068	1.023	0.201	0.368	2.867	0.883	0.142	26,426	-1.104	0.000710	1.4887	2.590	0.818
600CS18P			W= 1.500	0.0478	18	1.429	0.480	2.491	0.830	0.165	0.289	2.321	0.712	0.115	14,079	-1.114	0.000365	1.2271	2.604	0.817

6 C 14	6	0.074	2.31	0.720	3.663	1.221	2.256	0.226	0.414	50	36.6	30	0.723
6 C 16	6	0.059	1.86	0.578	2.966	0.989	2.265	0.186	0.413	50	29.7	30	0.668
6 C 18	6	0.047	1.49	0.463	2.392	0.797	2.272	0.152	0.413	33	15.8	19.8	0.663

PCS 6 x 20	6.000	1.625	0.563	1.300	0.231	1.994	0.654	2.284	0.106	0.592	0.429	12,941
PCS 6 x 18	6.000	1.625	0.563	1.622	0.320	2.467	0.822	2.274	0.143	0.585	0.427	16.280

PCS-6	x 18	6	1-5/8	9/16	.425	3.000	1.79	.435	20,000	.689	2.599	0.866	2.27	.172	.143	.583

6"	33,40	20	1.174	0.300	0.462	1.820	0.607	2.462	0.108	0.094	0.600	0.354	0.392	1.830	0.610	2.274	0.118	0.097	0.577	0.705	−1.097	0.152	0.875	2.590	0.821	12085
		18	1.554	0.397	0.456	2.394	0.798	2.456	0.140	0.122	0.594	0.469	0.386	2.407	0.802	2.267	0.153	0.126	0.571	0.699	−1.086	0.357	1.131	2.577	0.823	16906

6	CN	20	1.089	.3121	1.5383	.4654	2.2201	.0628	.0536	.4487	.4503	.000124	2.3982	-.7880	3.8119	.8920	10,166
		18	1.423	.4083	1.9992	.6423	2.2128	.0802	.0708	.4431	.5740	.000281	2.3871	-.7780	3.8414	.8938	14,358
		16	1.772	.5077	2.4685	.7862	2.2051	.0971	.0860	.4373	.6945	.000546	2.3755	-.7675	3.8738	.8956	26,702
		14	2.206	.6278	3.0178	.9836	2.1925	.1152	.1034	.4283	.8301	.001055	2.3585	-.7562	3.9705	.8972	34,325

600 WC	14	.0937	50	2.37	0.696	0.589	0.51	0.7137	30.00	3.538	1.176	2.258	0.203	0.564
	16	.0937	50	1.87	0.550	0.465	0.45	0.6554	30.00	2.809	0.934	2.263	0.158	0.559
	18	.0937	33	1.48	0.435	0.368	0.39	0.6467	19.80	2.229	0.741	2.266	0.122	0.552

60SJ20	6	5.921	1.27	1.89	0.300	0.0359	20.6	0.500	1.787	0.588	2.253	0.100	0.084	0.587	0.582	0.0002	0.8691	1.109
60SJ18		5.921	1.63	2.43	0.397	0.0478	22.7	0.500	2.351	0.779	2.246	0.144	0.114	0.581	0.653	0.0004	1.1239	1.098

C-6 x 14	6	1⅝	2½	9/16	2.204	0.549	30,000	0.729	3.656	1.219	2.258	0.202	0.572	0.562	36,570
C-6 x 16 (5)	6	1⅝	2½	9/16	1.791	0.444	29,208	0.675	2.972	0.991	2.267	0.167	0.579	0.562	28,945
C-6 x 18 (5)	6	1⅝	2½	9/16	1.437	0.358	19,181	0.670	2.406	0.802	2.274	0.137	0.585	0.562	15,383
C-6 x 20 (5)	6	1⅝	2½	⅜	1.039	0.257	17,572	0.600	1.743	0.581	2.271	0.090	0.553	0.508	10,192

Comparative properties for a 6” 18 gauge and flange width of 1-5/8”

Manufacturer	Area	Ixx	Iyy	Sxx
Cemco	0.480	2.491	0.165	0.830
Unimast	0.397	2.351	0.144	0.779
AllSteel	0.435	2.229	0.122	0.741
AMICO	0.320	2.467	0.143	0.822
Dale	0.441	2.268	0.139	0.733
Dietrich	0.397	2.394	0.140	0.798
AMICO/MAS	0.435	2.599	0.172	0.866
Clark	0.320	2.467	0.143	0.822
Bostwick	0.463	2.392	0.152	0.797
Incor	0.358	2.406	0.137	0.802

A comparative analysis between wood studs and Light-Gauge metal framing. Typical height of 8'-2" to depict an exterior curtain wall system…

Wood - using a nominal 2X4 – Southern Pine…

$A^{2x4} = 5.25\ in^2$

$S_x^{2x4} = 3.063\ in^3$

$S_y^{2x4} = 1.313\ in^3$

$I_x^{2x4} = 5.359\ in^4$

$I_y^{2x4} = 0.984\ in^4$

$F_b = 625\ psi$

$F_t = 350\ psi$

$F_c = 1500\ psi$

$F_c^{Perpendicular} = 565\ psi$

$F_V^{Parallel} = 90\ psi$

$E = 1{,}300{,}000\ psi$

$$L_b = \frac{8'-2"}{3}(12) = 32.67\ ins$$

Light-Gauge - using a 3-5/8CSJ20 by Dietrich…

$A = 0.215\ in^2$

$S_f = 0.309\ in^3$ and $S_c = 0.304\ in^3$

$I_{f-x} = 0.561\ in^4$

$I_{c-x} = 0.551\ in^4$

$r_x = 1.601\ ins$

$r_y = 0.620\ ins$

$x_0 = -1.345\ ins$

$r_0 = 2.066\ ins$

$J = 0.000115$

$C_w = 0.300$

$F_y = 40\ ksi$

$E = 29{,}500{,}000\ psi$

$G = 11{,}300\ psi$

$$L_b = \frac{8'-2"}{3}(12) = 32.67\ ins$$

Wind Loading… Exposure C, minimum of 90 MPH:

$$q_{Basic} = 0.00256(V)^2;$$

where...$V = 90\ \text{MPH}\ \therefore$

$$q_{Basic} = 0.00256(90)^2 = 20.74\ \text{psf}$$

$$K^{Height}_{Factor} = 2.01\left(\frac{15}{z_g}\right)^{\frac{2}{\alpha}};\ \text{for heights less than 15'-0"}$$

where...$z_g = 900$ and $\alpha = 9.5$ for exposure C $\therefore$

$$K^{Height}_{Factor} = 2.01\left(\frac{15}{900}\right)^{\frac{2}{9.5}} = 0.85 \xrightarrow{\text{Wind Pressure...}}$$

$$q^{Windward} = 0.8(20.74)0.85 = 14.01\text{psf}$$

With Studs at 16" o.c.:

$$w^{Windward}_{Wind} = \frac{16}{12}(14.01) \cong 18.8\ \text{lbs/ft}$$

$$M = \frac{wL^2}{8}\ \text{where...}w = \text{uniform load and L is the stud height...}$$

$$M^{Windward}_{Wind} = \frac{18.8(8'-2")^2}{8} = 156.57^{\text{lbs-ft}} = 0.157^{\text{kips-ft}}$$

Stud Design Analysis…

Light-Gauge - using a 3-5/8CSJ20 by Dietrich…

$$F_e = \frac{C_b r_0 A}{S_f}\sqrt{\sigma_{ey}\sigma_t} \text{ where } C_b = 1.0$$

$$\sigma_{ey} = \frac{\pi^2 E}{\left(\frac{K_y L_y}{r_y}\right)^2} = \frac{\pi^2\left(29.5x10^3\right)}{\left(\frac{32.67}{0.620}\right)^2} = 104.86 \text{ ksi; where } K_y = 1.0$$

$$\sigma_t = \frac{1}{Ar_0^2}\left[GJ + \frac{\pi^2 EC_w}{(K_t L_t)^2}\right]$$

$$\sigma_t = \frac{1}{0.215(2.066)^2}\left[11.3x10^3(0.000115) + \frac{\pi^2\left(29.2x10^3\right)(0.3)}{(32.67)^2}\right]$$

$$\sigma_t = 90.59 \text{ ksi}$$

$$F_e = \frac{1.0(2.066)(0.215)}{0.309}\sqrt{(104.86)(90.59)}$$

$$F_e = 140.11 \text{ ksi and...}$$

$$0.56F_y = 22.4 \text{ ksi}$$

$$2.78F_y = 111.20 \text{ ksi} < F_e \quad \therefore \quad F_c = F_y = 40 \text{ ksi}$$

$$M_n = S_c F_c \Rightarrow M_n = 0.304(40) = 12.16^{k-in}$$

$$w_{max} = \frac{8(12.16)}{\left(8'-2"(12)\right)^2} = 0.010 \,{}^{k}\!/_{in} = 10.129 \,{}^{lbs}\!/_{in}$$

$$\Delta_{\frac{L}{360}} = \left(\frac{(8'-2")12}{360}\right) = 0.272 \text{ ins}$$

$$\Delta_{\frac{L}{240}} = \left(\frac{(8'-2")12}{240}\right) = 0.408 \text{ ins}$$

$$w_{max}^{L/360} = \frac{0.272(384)29.5x10^3(0.551)}{5\left(8'-2"(12)\right)^4} = 0.004 \,{}^{kips}\!/_{in} = 3.68 \,{}^{lbs}\!/_{in}$$

$$w_{max}^{L/240} = \frac{0.408(384)29.5x10^3(0.551)}{5\left(8'-2"(12)\right)^4} = 0.006 \,{}^{kips}\!/_{in} = 5.52 \,{}^{lbs}\!/_{in}$$

Stud Design Analysis…cont

Wood - using a 2X4 – Southern Pine…

$$l_u = 32.67 \text{ ins}$$

$$\frac{l_u}{d} = \frac{32.67}{3\frac{1}{2}} = 9.33 \therefore\ 7 \le \frac{l_u}{d} \le 14.3 \ \Rightarrow l_e = 1.63(l_u) + 3d$$

$$l_e = 1.63(32.67) + 3(3.5) = 63.75 \text{ ins}$$

$$R_B = \sqrt{\frac{l_e(d)}{b^2}} = \sqrt{\frac{63.75(3.5)}{1.5^2}} = 9.958 < 50 \text{ OK.}$$

$$K_{bE} = 0.438, \text{ since } COV_E > 0.11$$

$$\frac{K_{bE}}{R_B^2}(E'_y) = \frac{0.438(1.3x10^6)}{(9.958)^2} = 57{,}255 \text{ psi}$$

$$\frac{F_{bE}}{F_b} = \frac{57{,}255}{625} = 91.61$$

$$C_L = \frac{1+\frac{F_{bE}}{F_b}}{1.9} - \left[\sqrt{\left[\frac{1+\frac{F_{bE}}{F_b}}{1.9}\right]^2 - \frac{\frac{F_{bE}}{F_b}}{0.95}}\right]$$

$$C_L = \frac{1+91.61}{1.9} - \left[\sqrt{\left[\frac{1+91.61}{1.9}\right]^2 - \frac{91.61}{0.95}}\right] \cong 1.00$$

$$C_L = 1.00$$

$$C_V = K_L\left(\frac{5.125}{b}\right)^{1/x}\left(\frac{12}{d}\right)^{1/x}\left(\frac{21}{L}\right)^{1/x} \le 1.0 \text{ where x = 20 for Southern Pine}$$

$$K_L = 1.0 \text{ (...for uniformly distributed load)} \ \therefore$$

$$C_V = 1.0\left(\frac{5.125}{1.5}\right)^{1/20}\left(\frac{12}{3.5}\right)^{1/20}\left(\frac{21}{8.17}\right)^{1/20} = 1.186$$

$$C_V = 1.186 > C_L \text{ USE!}$$

$$F'_b = 1.186(625) = 741 \text{ psi}$$

$$M_{max} = F'_b(S_x) = 741(3.063) = 2{,}270^{lbs-in} = 189^{lbs-ft}$$

$$w_{max} = \frac{8(189)}{(8.17)^2} = 22.7 \, {}^{lbs}\!/_{ft} = 1.89 \, {}^{lbs}\!/_{in}$$

$$\Delta_{\frac{L}{360}} = \left(\frac{(8'-2")12}{360}\right) = 0.272 \text{ ins}$$

$$\Delta_{\frac{L}{240}} = \left(\frac{(8'-2")12}{240}\right) = 0.408 \text{ ins}$$

$$w_{max}^{L/360} = \frac{0.272(384)1.3x10^6(5.359)}{5(98)^4} = 1.58 \, {}^{lbs}\!/_{in}$$

$$w_{max}^{L/240} = \frac{0.408(384)1.3x10^6(5.359)}{5(98)^4} = 2.367 \, {}^{lbs}\!/_{in}$$

Wood - using a 2X4 – Southern Pine…

Limiting Load:

$$w_{max} = 1.89 \, {}^{lbs}\!/_{in}$$

$$\Delta_{\frac{L}{360}} = 0.272 \text{ ins}$$

$$\Delta_{\frac{L}{240}} = 0.408 \text{ ins}$$

$$w_{max}^{L/360} = 1.58 \, {}^{lbs}\!/_{in}$$

$$w_{max}^{L/240} = 2.367 \, {}^{lbs}\!/_{in}$$

$$Spa_{stress}^{max} = \frac{1.89}{14.01}(12) \cong 1'-7"$$

$$Spa_{L/360}^{max} = \frac{1.58}{14.01}(12) \cong 1'-4"$$

$$Spa_{L/240}^{max} = \frac{2.367}{14.01}(12) \cong 2'-0"$$

Light-Gauge - using a 3-5/8CSJ20 by Dietrich…

Limiting Load:

$$w_{max} = 10.129 \, {}^{lbs}\!/_{in}$$

$$\Delta_{\frac{L}{360}} = 0.272 \text{ ins}$$

$$\Delta_{\frac{L}{240}} = 0.408 \text{ ins}$$

$$w_{max}^{L/360} = 3.68 \, {}^{lbs}\!/_{in}$$

$$w_{max}^{L/240} = 5.52 \, {}^{lbs}\!/_{in}$$

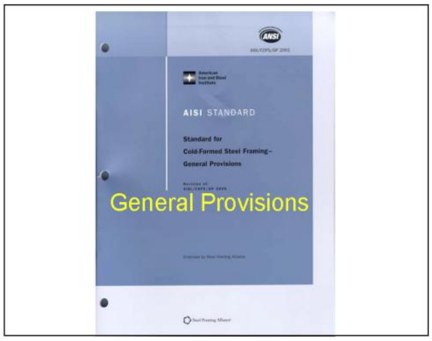
$$Spa_{stress}^{max} = \frac{10.129}{14.01}(12) \cong 8'-8"$$

$$Spa_{L/360}^{max} = \frac{3.68}{14.01}(12) \cong 3'-2"$$

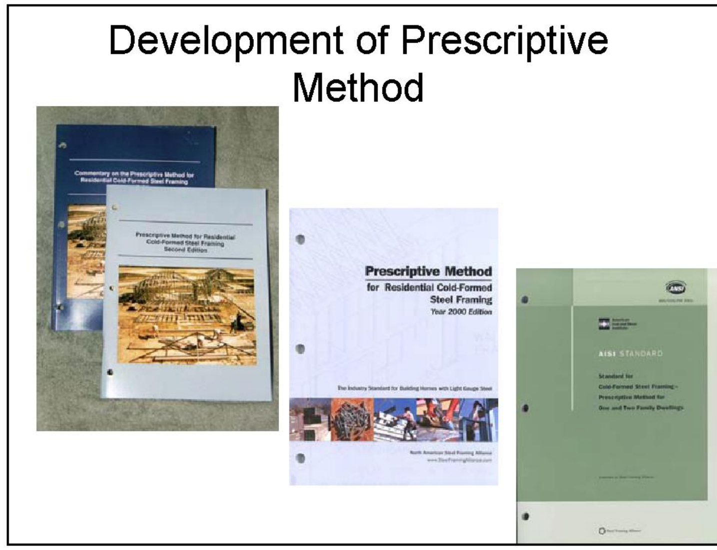
$$Spa_{L/240}^{max} = \frac{5.52}{14.01}(12) \cong 4'-9"$$

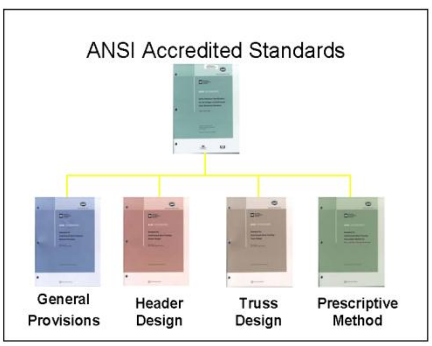
"…Do the numbers in red look familiar?"

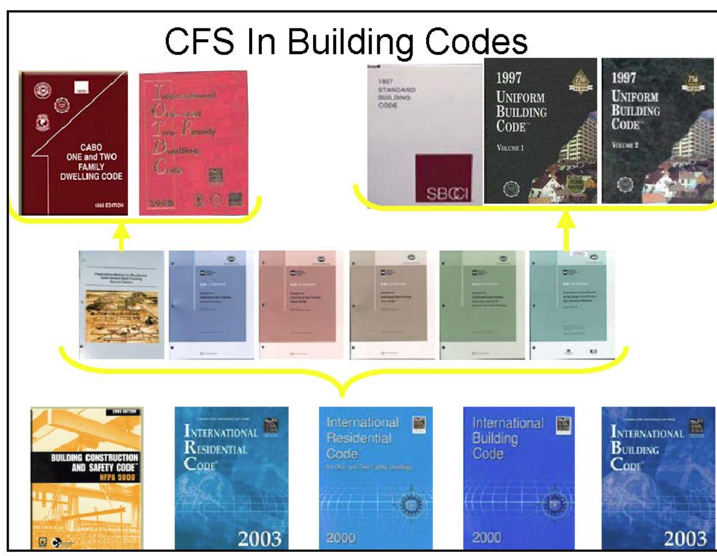
The strength of Light-Gauge metal framing is quite evident. The spacing, excluding axial load for both cases analyzed, exemplifies that only sheathing materials such as plywood, or exterior cement boards limits the current spacing of wall studs.



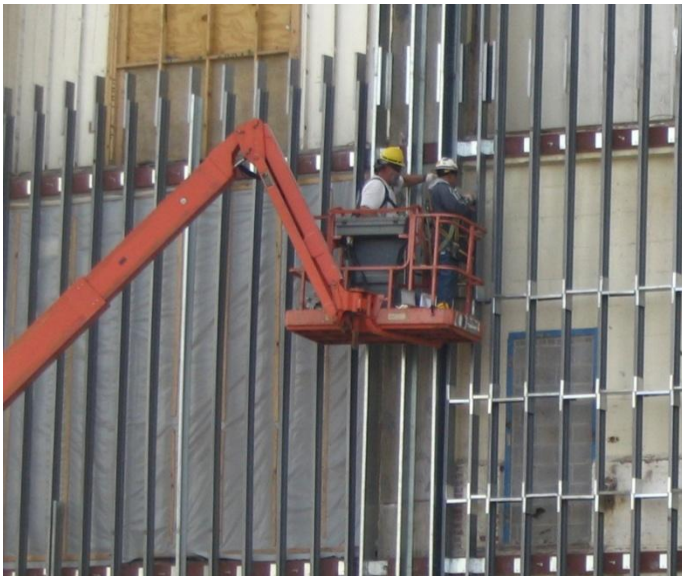
"Design Codes…"







Building Codes have addressed the use of Light-Gauge designs and have become part of the family of controlling Codes accepted by the Industry.



Old Meets New In Orlando

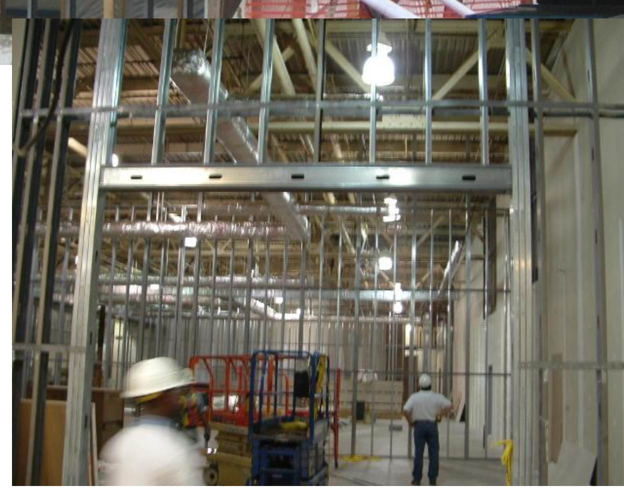
The cathedral of steel framing is a symbol of new horizons for wall and ceiling contractors.

Gothic windows are old, computers are new. Cobblestone is old, load bearing lightweight steel framing is new. Put old and new together and you might come up with something really interesting.

Gene Farach could be described as a "pioneer" in the building field. His new ideas come from using computer programming to combine structural analysis with light gauge steel framing. The result is a luxury office complex featuring large Gothic windows, soaring loft ceilings, 22-ft.-high cathedral ceilings, and cobblestone paving, in a style reminiscent of New Orleans.

Wekiva Oaks is advertised as "luxury space for the office connoisseur." Farach, principal owner of the Farach Group in Longwood (FL) is a

14 WALLS & CEILINGS/AUGUST 1987

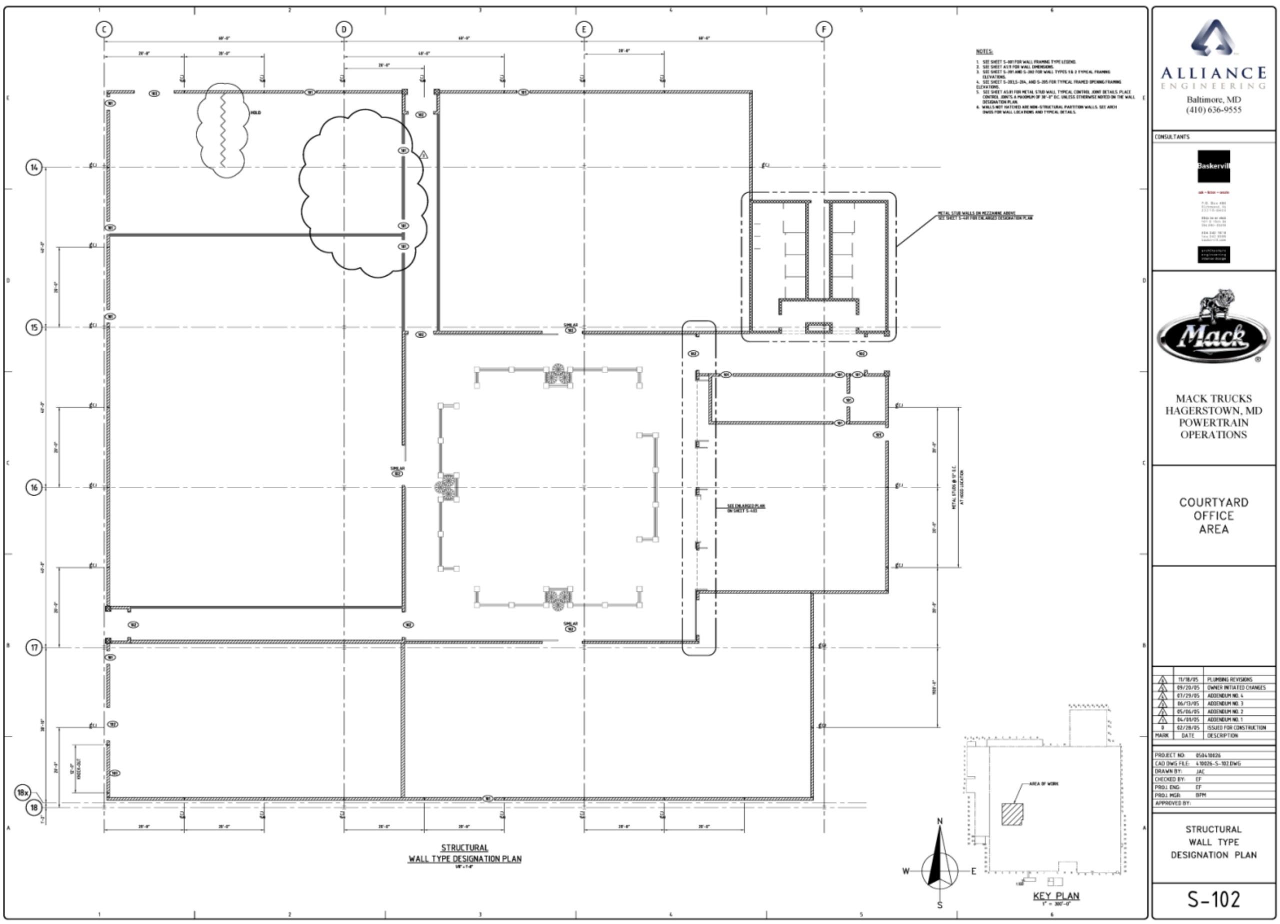


"Wall Systems…"

Curtain wall systems ARE structural. The very first wind resisting system within the building are the curtain walls. These transfer the wind loads to the vertical wind resisting system of the building…should we leave this design task to a "shop-drawing" review?

Gene Farach, PE
Senior Project Engineer

"Wall Systems…"

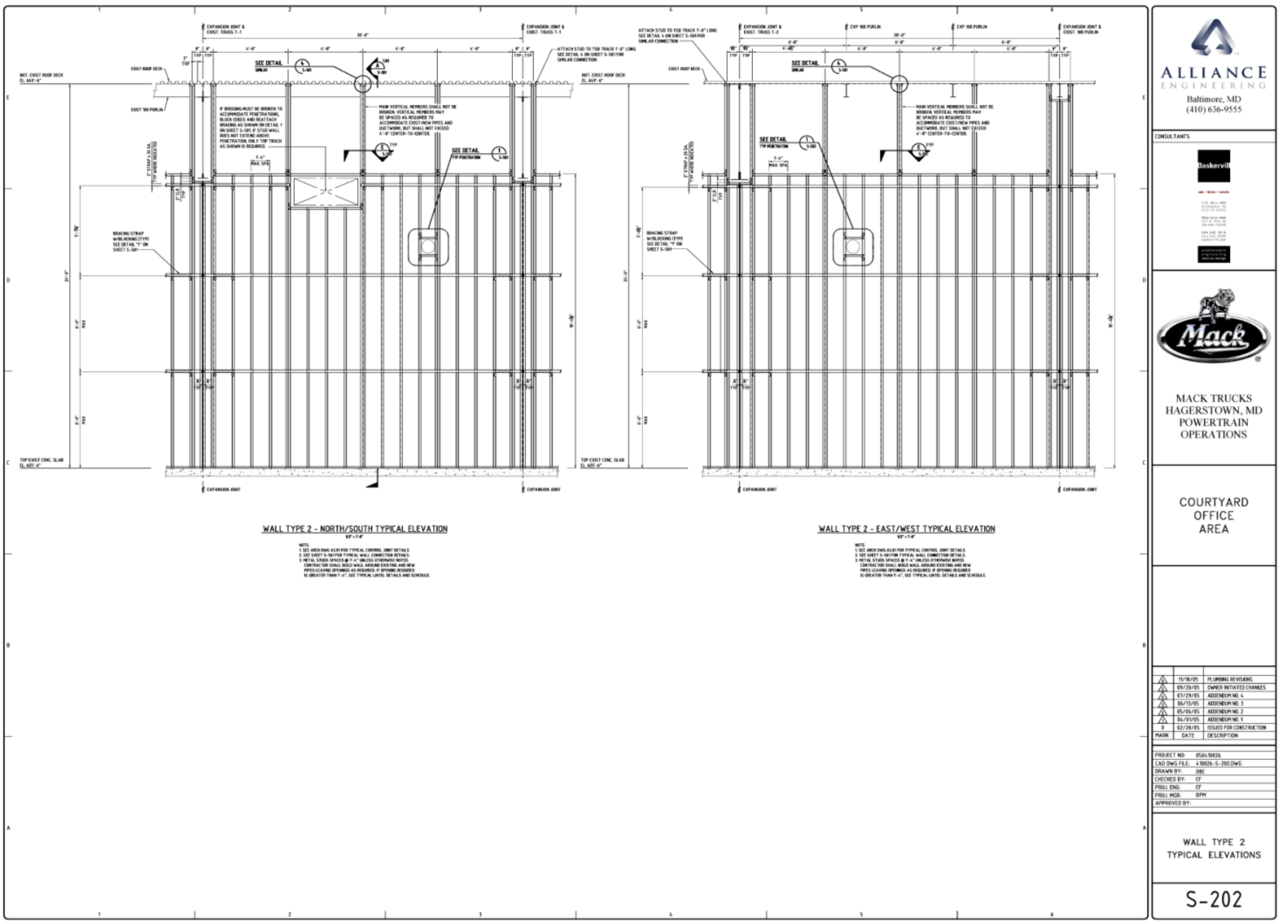


Interior walls systems need to be designed for any loads imposed onto the walls such carrying shelves, TV's, or simply 5 psf per IBC. Walls in atrium or otherwise exposed to frontage and/or entries to the building which could be compromised in the case of a design storm must be designed for 18% of the exterior wind loading or 17 psf for 90 PMH minimum wind loading!

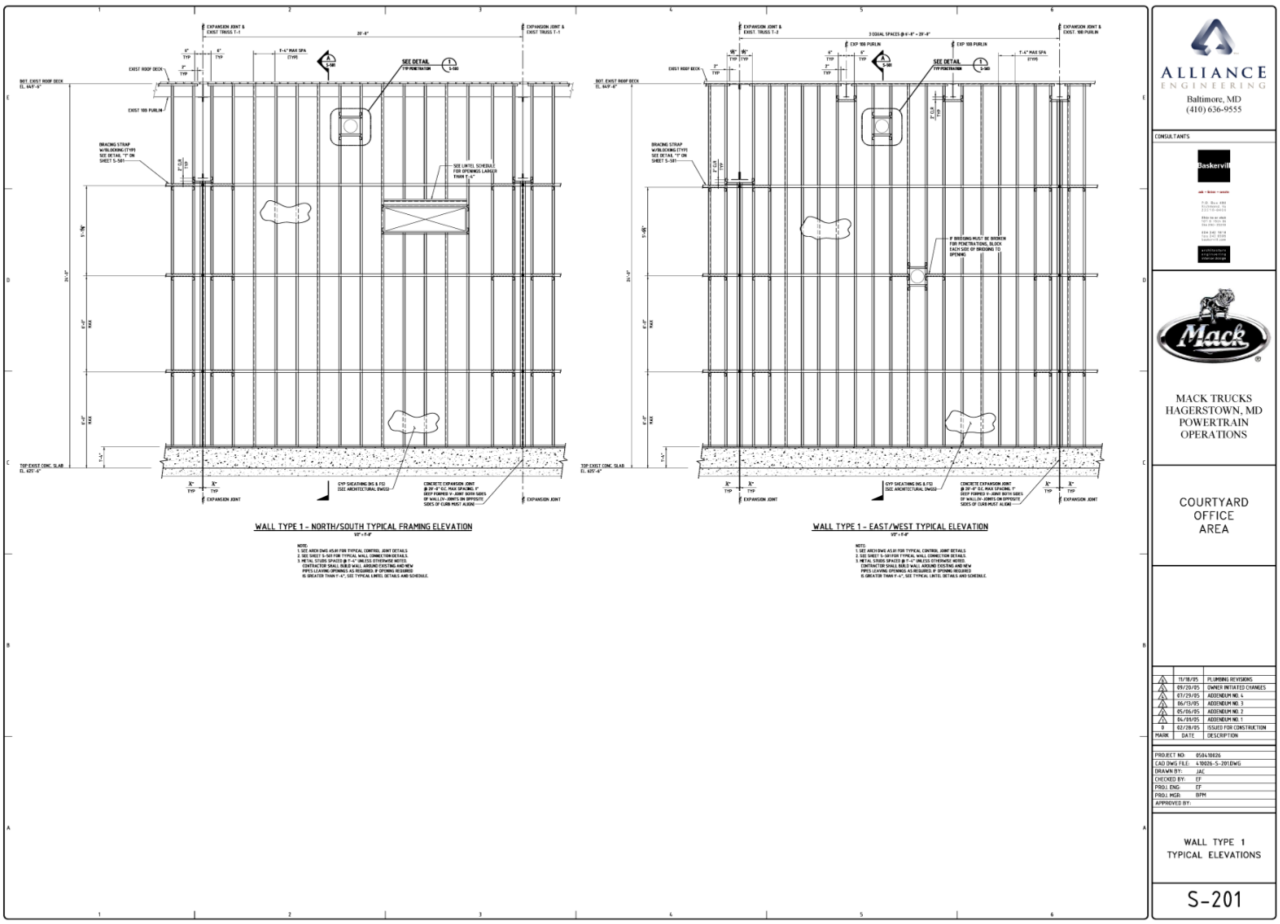
This is a sample project where walls were 27'-0" tall in an interior application…

Gene Farach, PE
Senior Project Engineer

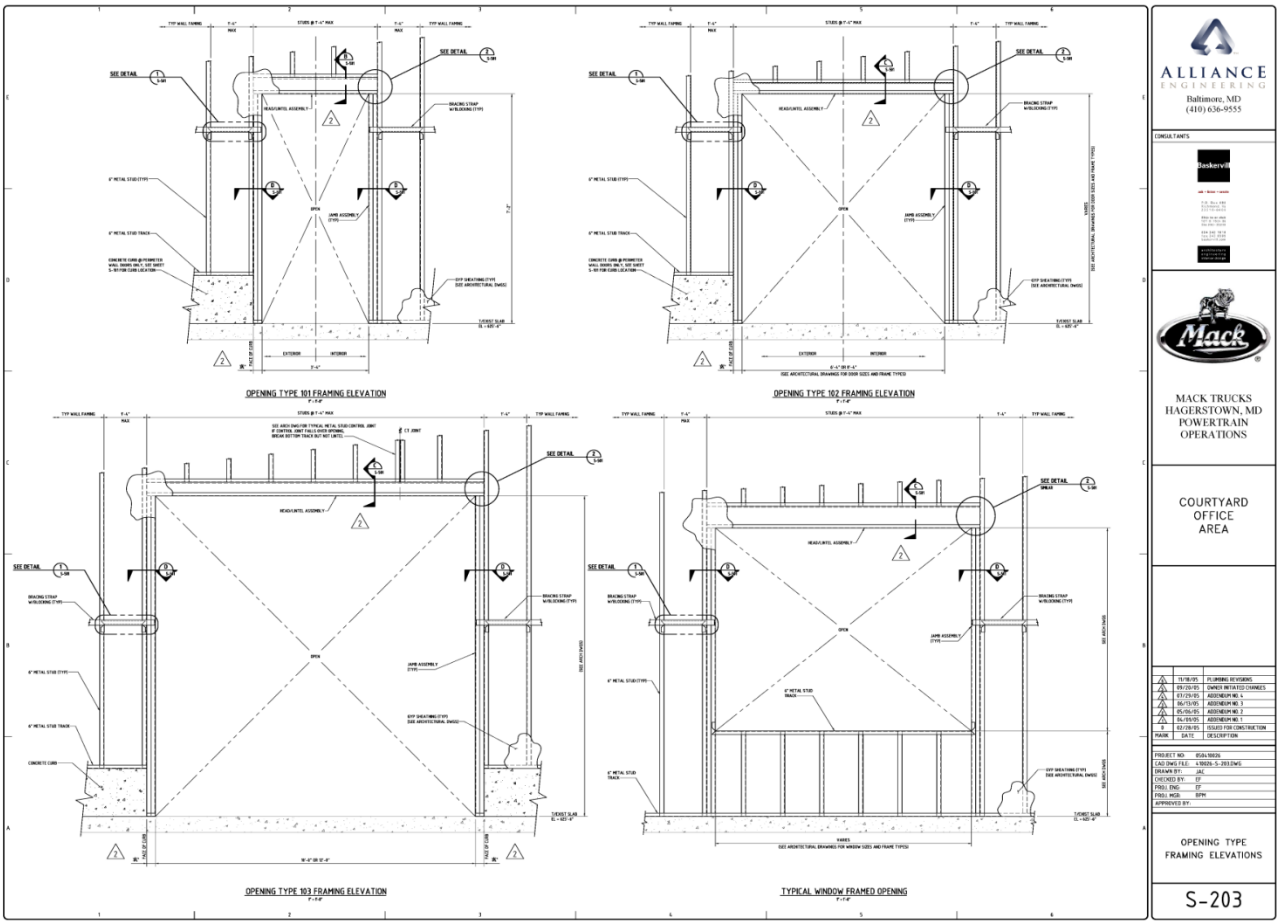
"Wall Systems…"

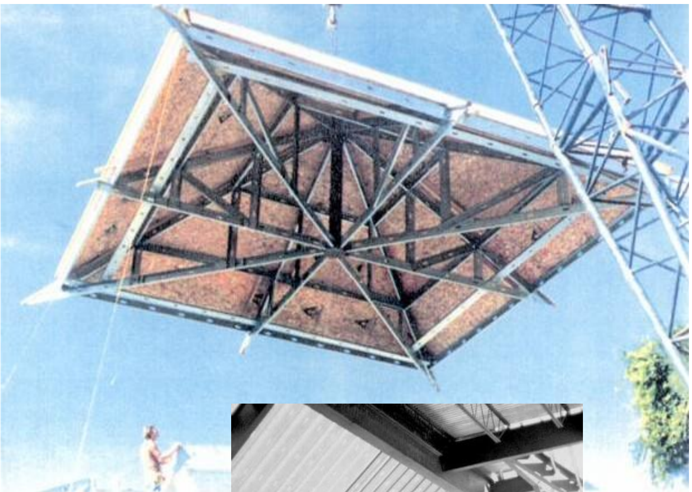


"Wall Systems…"



"Wall Systems…"

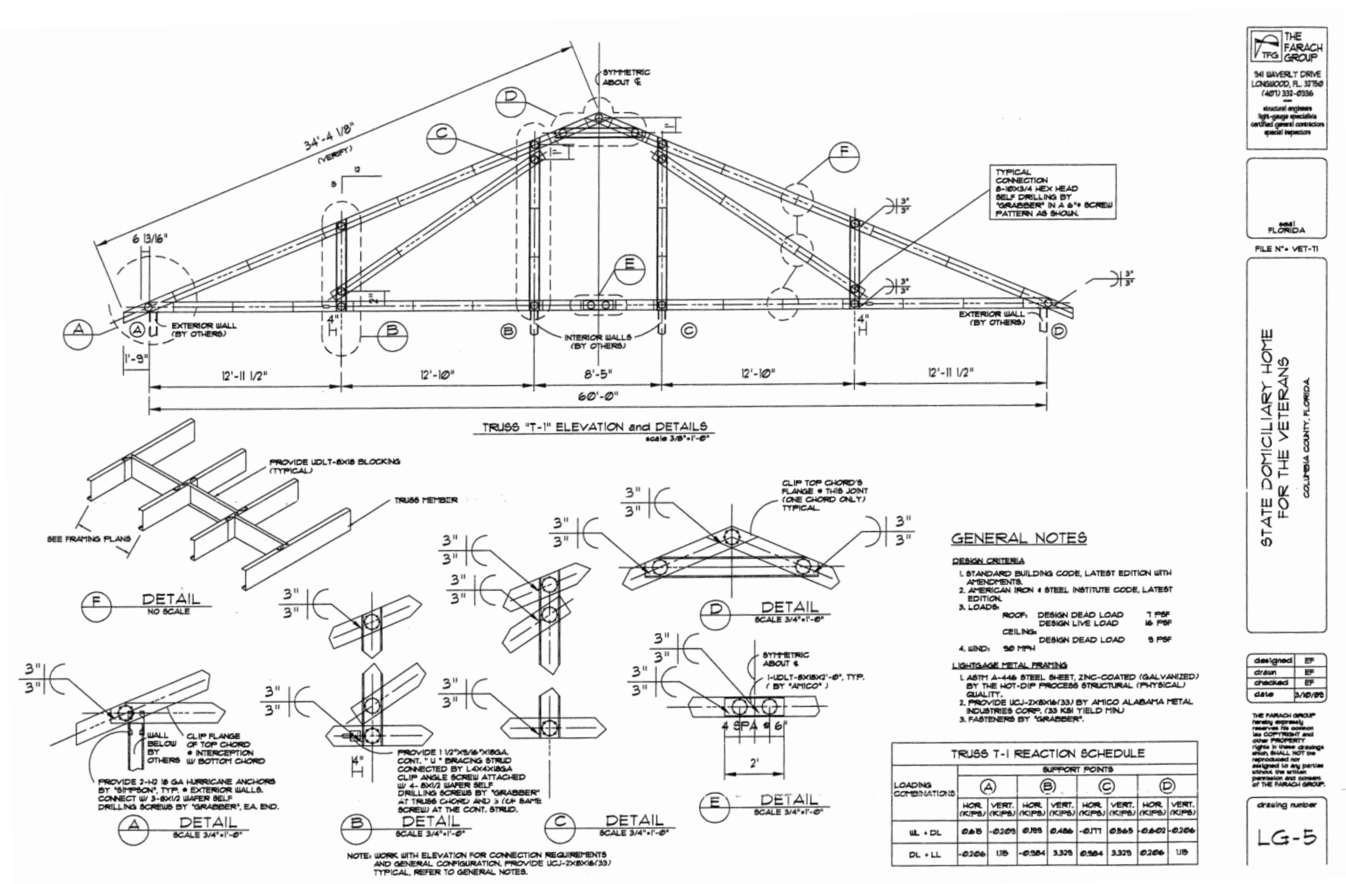




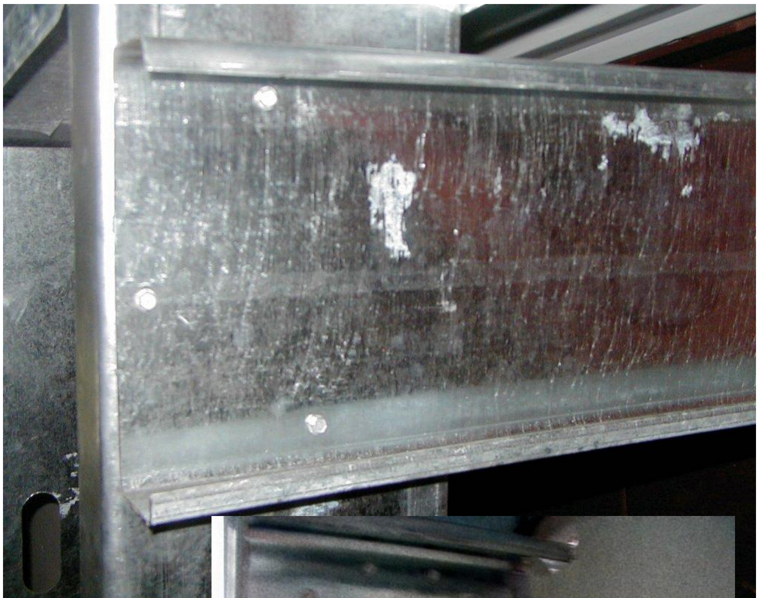
"Truss Systems…"

Trusses are very popular Light-Gauge framing systems. The most cumbersome design aspect are the connections. But, these systems need to resist windward and leeward wind loadings depending on their shape and pitch…what follows is a sample drawing of a 60'-0" span truss. Notice the minimum number of elements framing the system.

"Truss Systems…"



Truss design sample drawing….

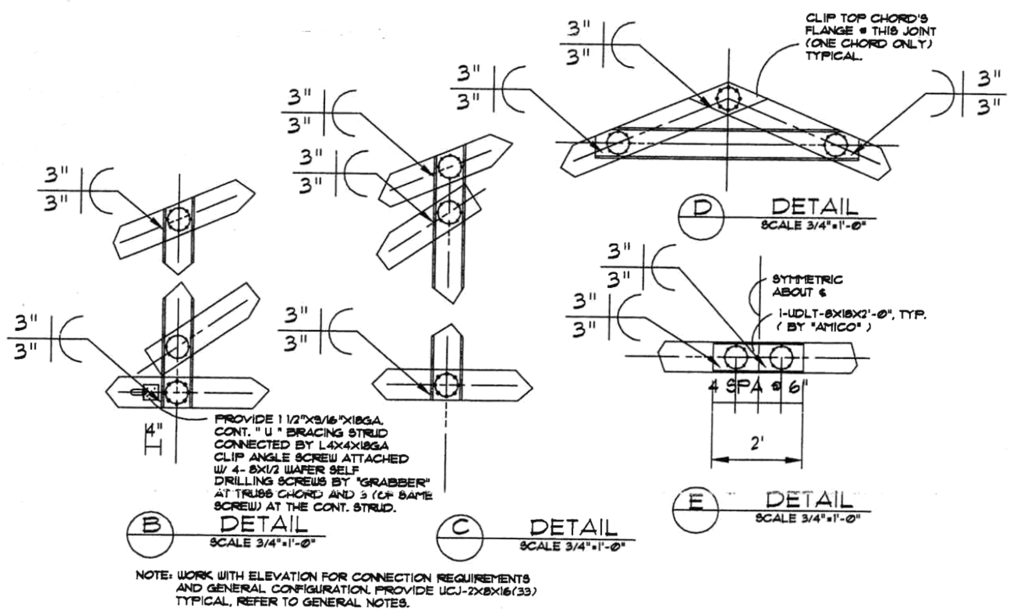


"Connections…"

Connections are the item of design where "Shop-Drawing" review fails miserably.

Details are critical and their strength relies on the proper selection of fasteners and method of welding.

All fasteners are different and there are few manufacturers who have actually tested the strength of their products in the actual sheet metal to document ultimate values for the various gauges.



"Fastener Types…"

TABLE 1—METAL-TO-METAL CONNECTIONS, ALLOWABLE SCREW LOADS FOR TENSION AND SINGLE SHEAR (pounds)

GAGE OF MATERIAL NOT IN CONTACT WITH SCREW HEAD

GAGE OF MATERIAL IN CONTACT WITH SCREW HEAD

GAGE Thickness (inch) Thickness (mm) F_y = ksi		25 0.0188 18 33	25 0.0188 18 33	20 0346 33 33	20 0.0346 33 33	18 0.0451 43 33	18 0.0451 43 33	16 0.0565 54 50	16 0.0565 54 50	14 0.0713 68 50	14 0.0713 68 50	12 0.1017 97 50	12 0.1017 97 50
Allowable Loads	Nominal Screw Dia. (inch)	Shear	Tension (pullout)	Shear	Tension (pullout)	Shear	Tension (pullout)	Shear	Tension (pullout)	Shear	Tension (pullout)	Shear	Tension (pullout)
#7 Streaker	0.151	98	40	327	89	—	—	—	—	—	—	—	—
#8 Streaker	0.164	130	58	314	137	—	—	—	—	—	—	—	—
#6 Self-drill	0.138	—	—	223	95	319	115	317	—	—	—	—	—
#8 Self-drill	0.164	—	—	272	106	418	136	382	177	405	180	—	—
#10 Self-drill	0.19	—	—	271	147	429	166	533	217	558	263	664	433
#12 Self-drill	0.216	—	—	268	140	435	160	551	233	731	231	814	390
#14 Self-drill	0.250	—	—	299	96	451	184	594	224	798	241	970	386

"Connection Accessories in the Market…"

"Welding is acceptable…"

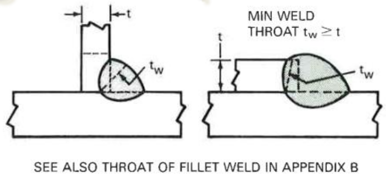


Figure 2.3 — Fillet Welds (See 2.2.4.1)

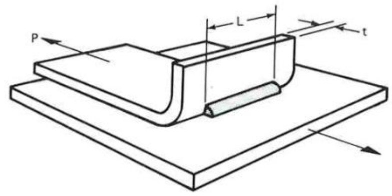


Figure 2.4A — Single Flare-Bevel Groove Weld (See 2.2.5(1))

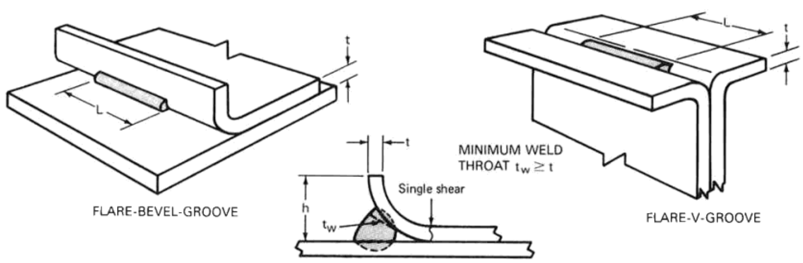
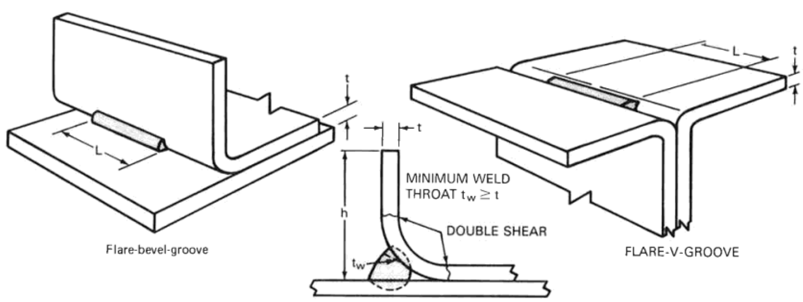


Figure 2.4B — Single Shear in Flare-Groove Welds (See 2.2.5(2))



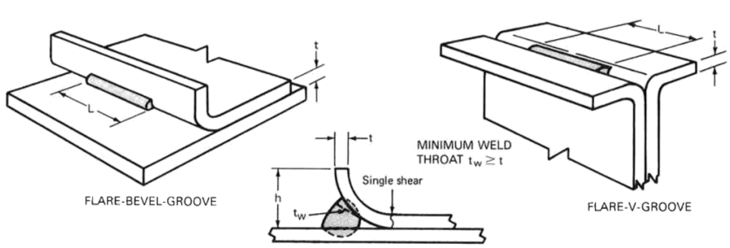


Figure 2.4B — Single Shear in Flare-Groove Welds (See 2.2.5(2))

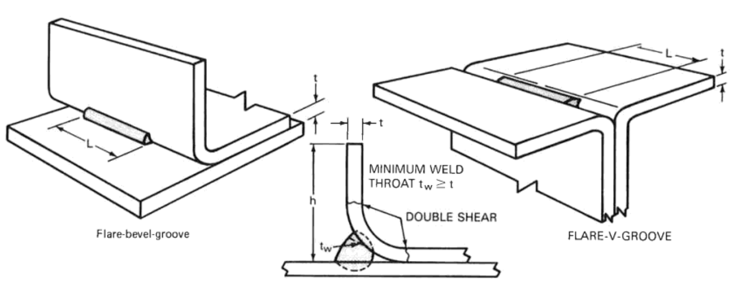
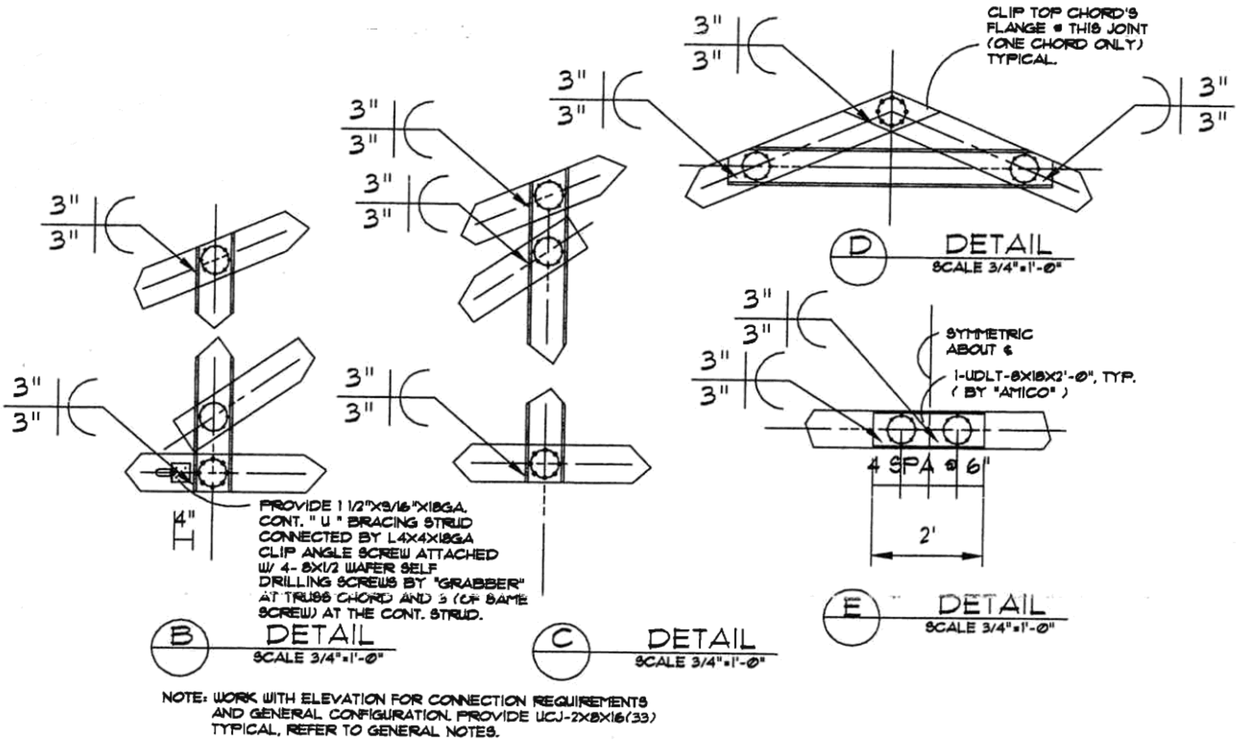
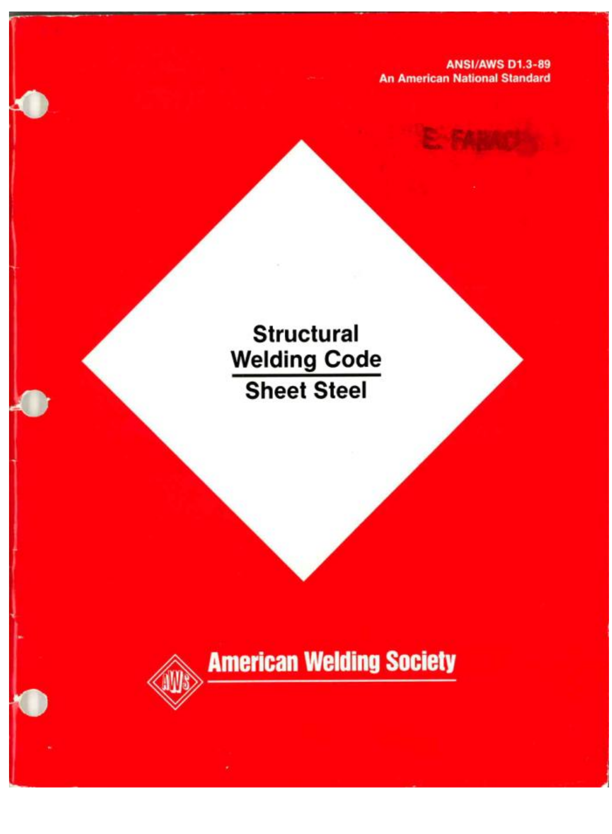


Figure 2.4C — Double Shear in Flare-Groove Welds (See 2.2.5(2))

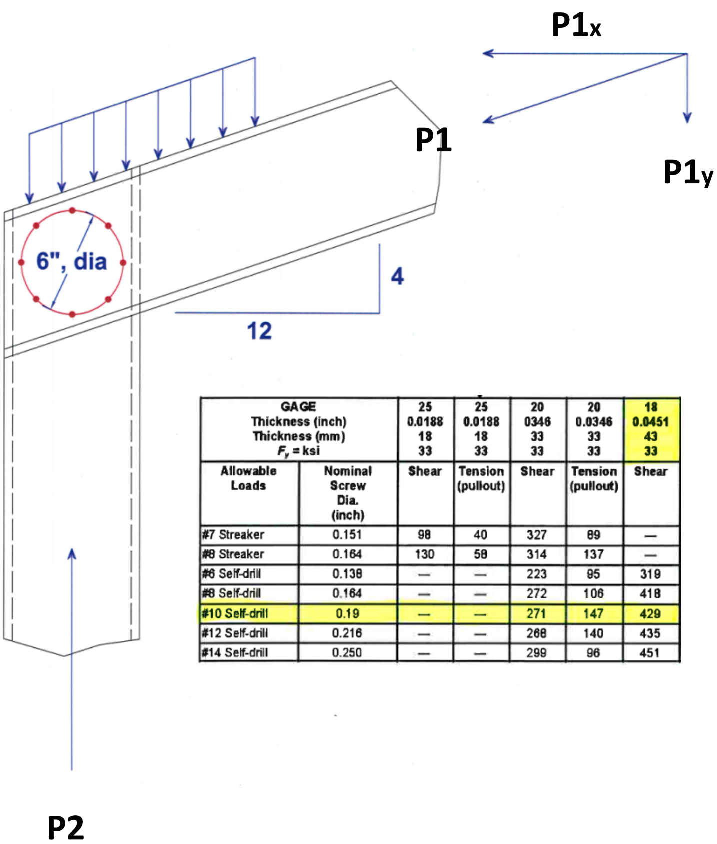


Welding require that a field testing program be implemented to insure that this procedure follows the AWS recommendations.

Only certified welders are permitted and they must submit their certification before they are contracted to do the work.



Sample calculation...



GAGE Thickness (inch) Thickness (mm) F_y = ksi		25 0.0188 18 33	25 0.0188 18 33	20 0346 33 33	20 0.0346 33 33	18 0.0451 43 33
Allowable Loads	Nominal Screw Dia. (inch)	Shear	Tension (pullout)	Shear	Tension (pullout)	Shear
#7 Streaker	0.151	98	40	327	89	—
#8 Streaker	0.164	130	58	314	137	—
#6 Self-drill	0.138	—	—	223	95	319
#8 Self-drill	0.164	—	—	272	106	418
#10 Self-drill	0.19	—	—	271	147	429
#12 Self-drill	0.216	—	—	268	140	435
#14 Self-drill	0.250	—	—	299	96	451

$$L = 12'-0"$$

$$W_{TL} = 0.050 \text{ k/ft}$$

$$P_1 = 2.25^K$$

$$\phi = a\tan\left(\frac{4}{12}\right) = 18.435^0$$

$$V = 0.050\left(\frac{12}{2}\right) = 0.300^K$$

$$P_1^x = 2.25\left(\cos\left(18.435^0\right)\right) = 2.135^K$$

$$P_1^y = 2.25\left(\sin\left(18.435^0\right)\right) = 0.712^K$$

$$P_2 = 0.300 + 0.712 = 1.012$$

$$M = \frac{0.050(12)^2}{12} = 0.6^{K-FT} = 7.2^{K-IN}$$

Using a total of 8 screws...

...Resultants due to Loads:

$$q_r^P = \sqrt{\left(\frac{2.135}{8}\right)^2 + \left(\frac{1.012}{8}\right)^2} = 0.295^K$$

...Resultant due to Moment:

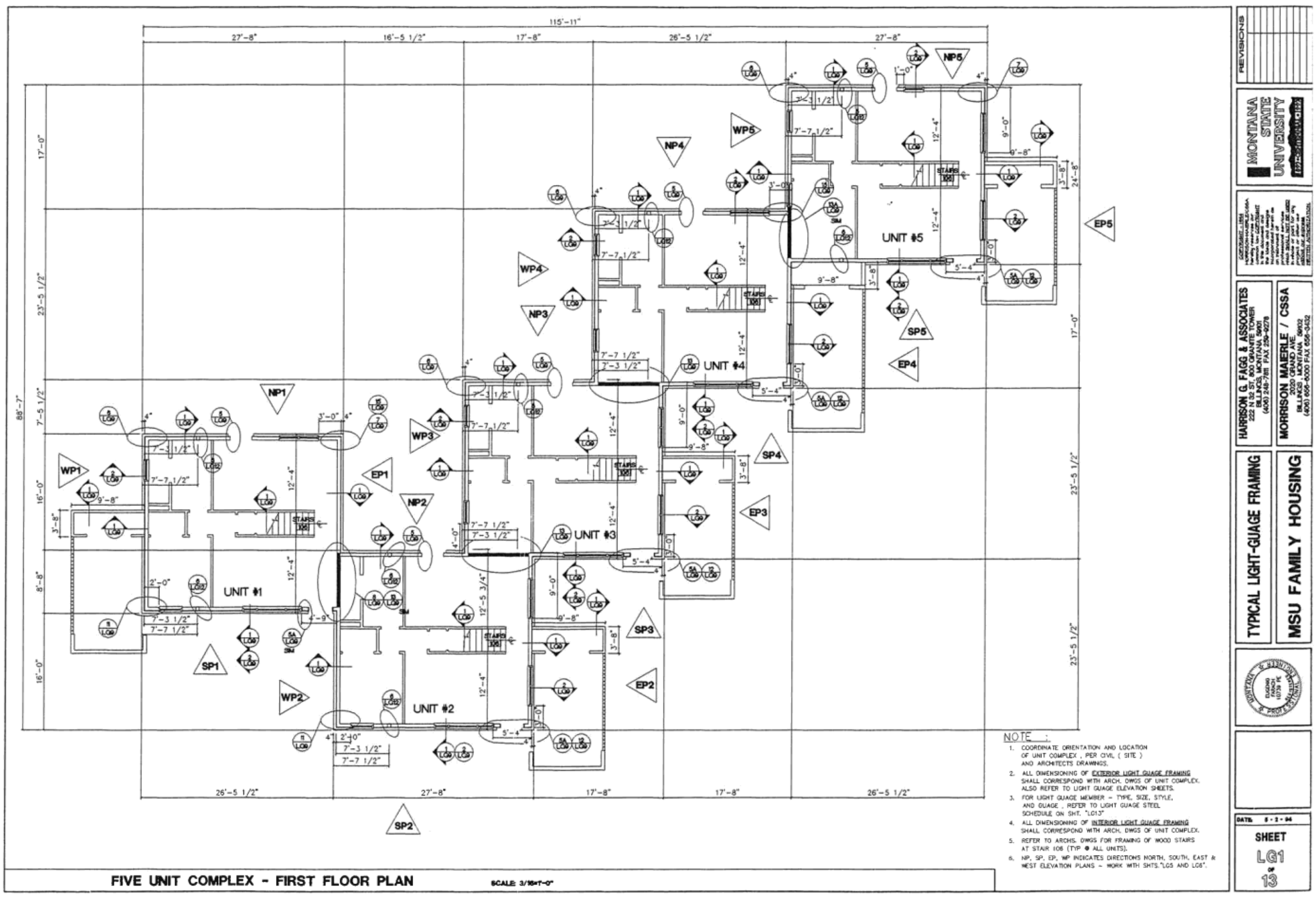
$$q_r^M = \frac{7.2}{3(8)} = 0.300^K$$

$$q_r = \sqrt{(0.295)^2 + (0.300)^2} = 0.421^K \text{ vs } 0.429^K$$

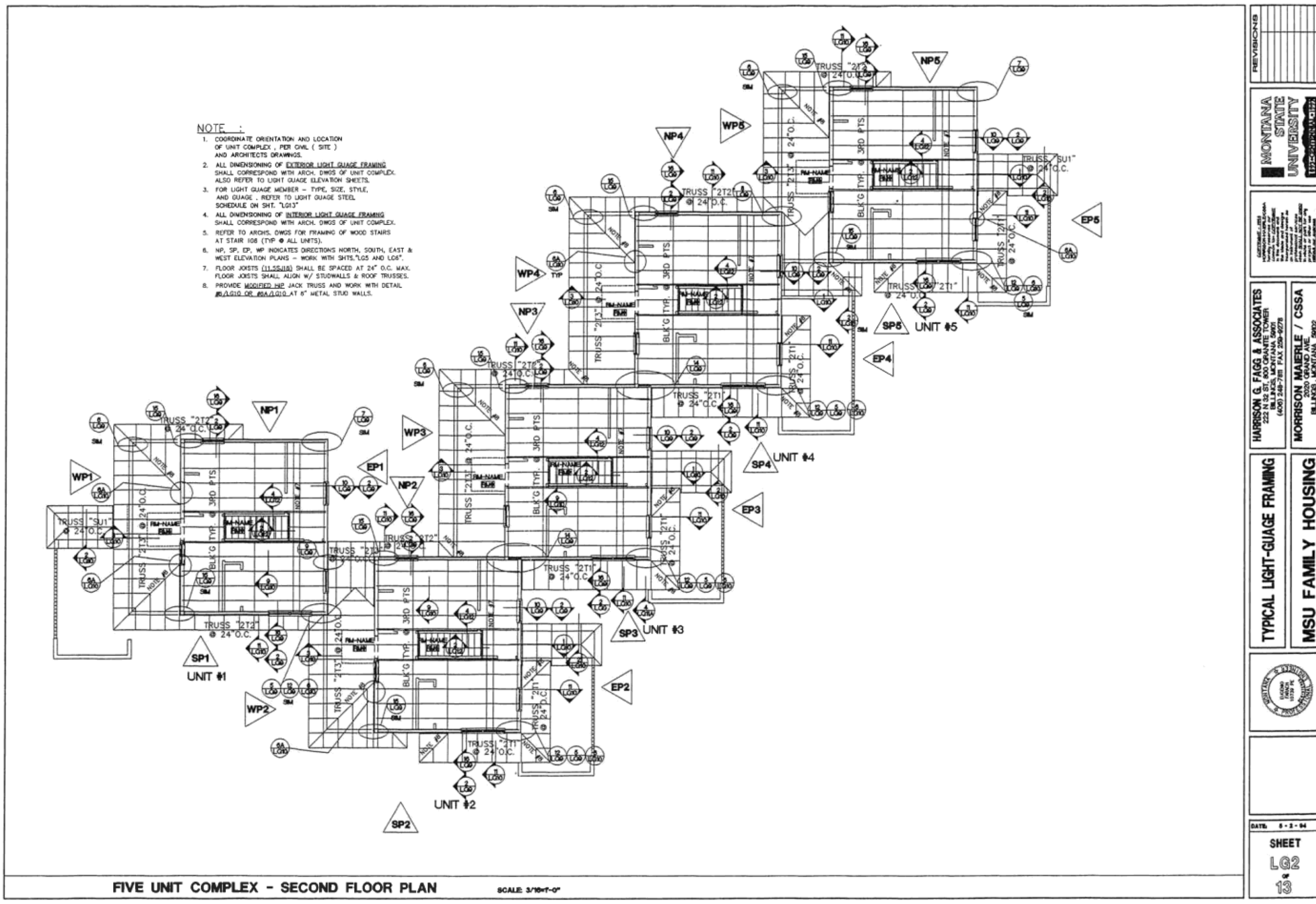
OK!

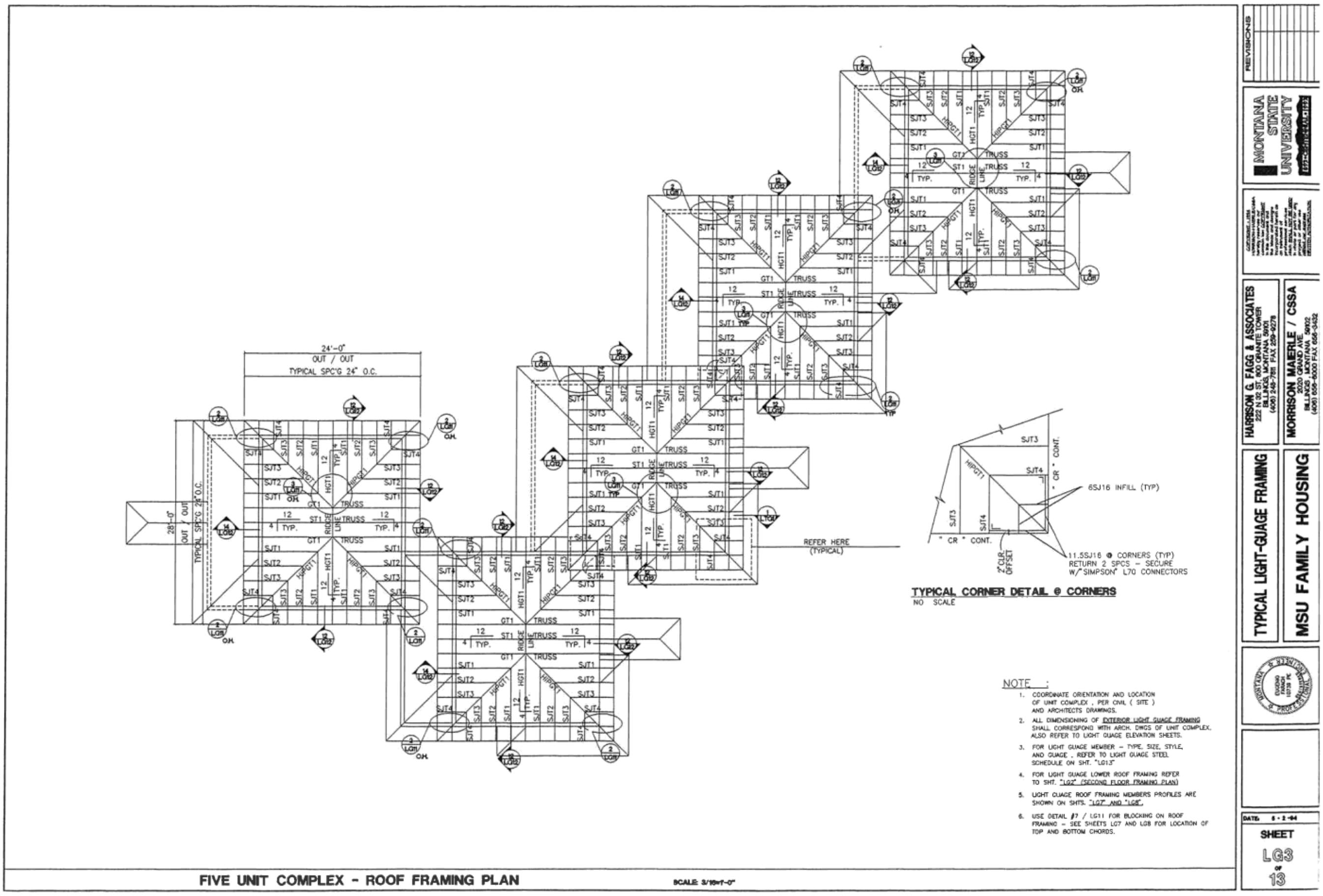
Use 8-#10 Self-Drill screws...

"A Building's Light-Gauge Design Documents Sample …"

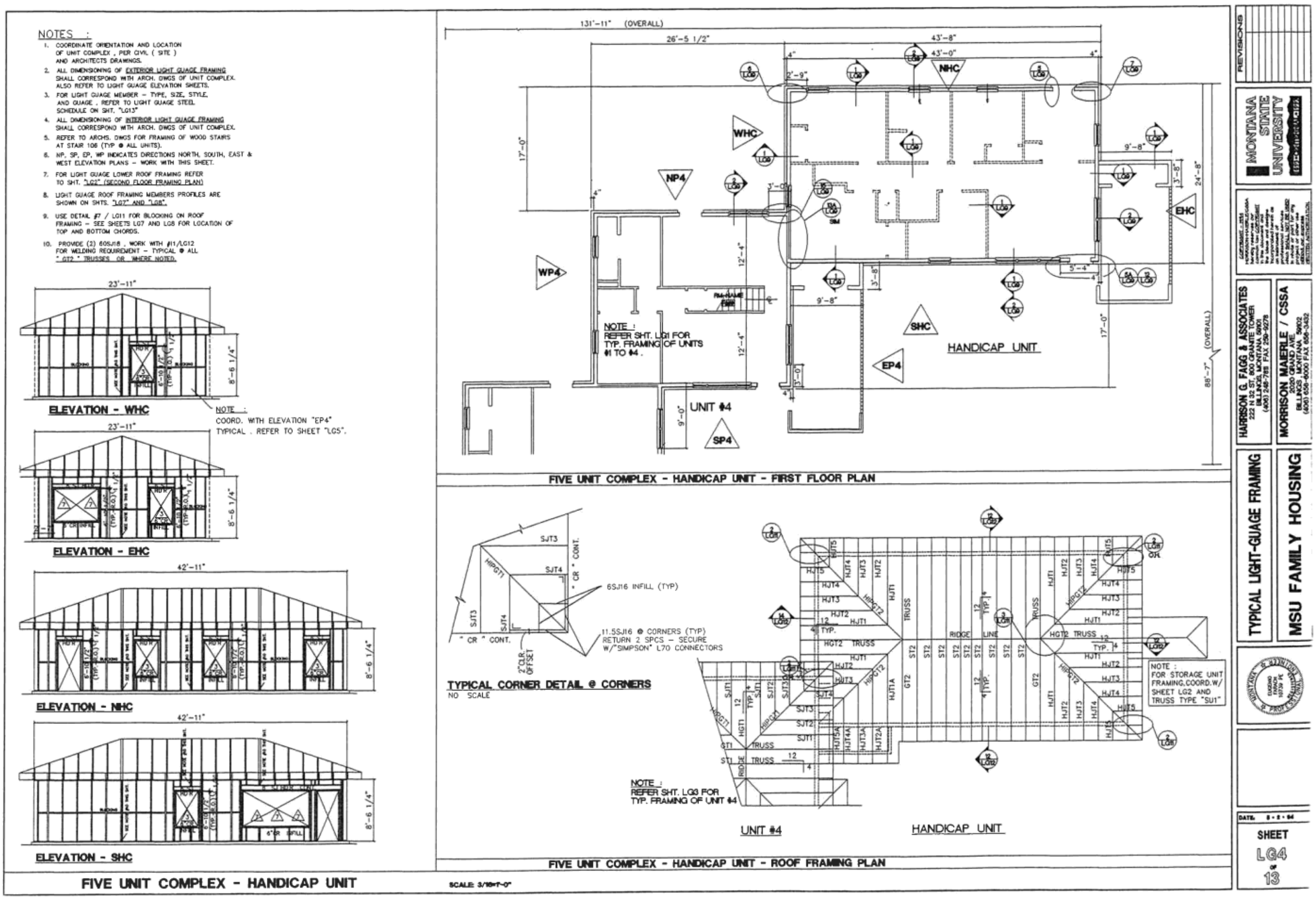


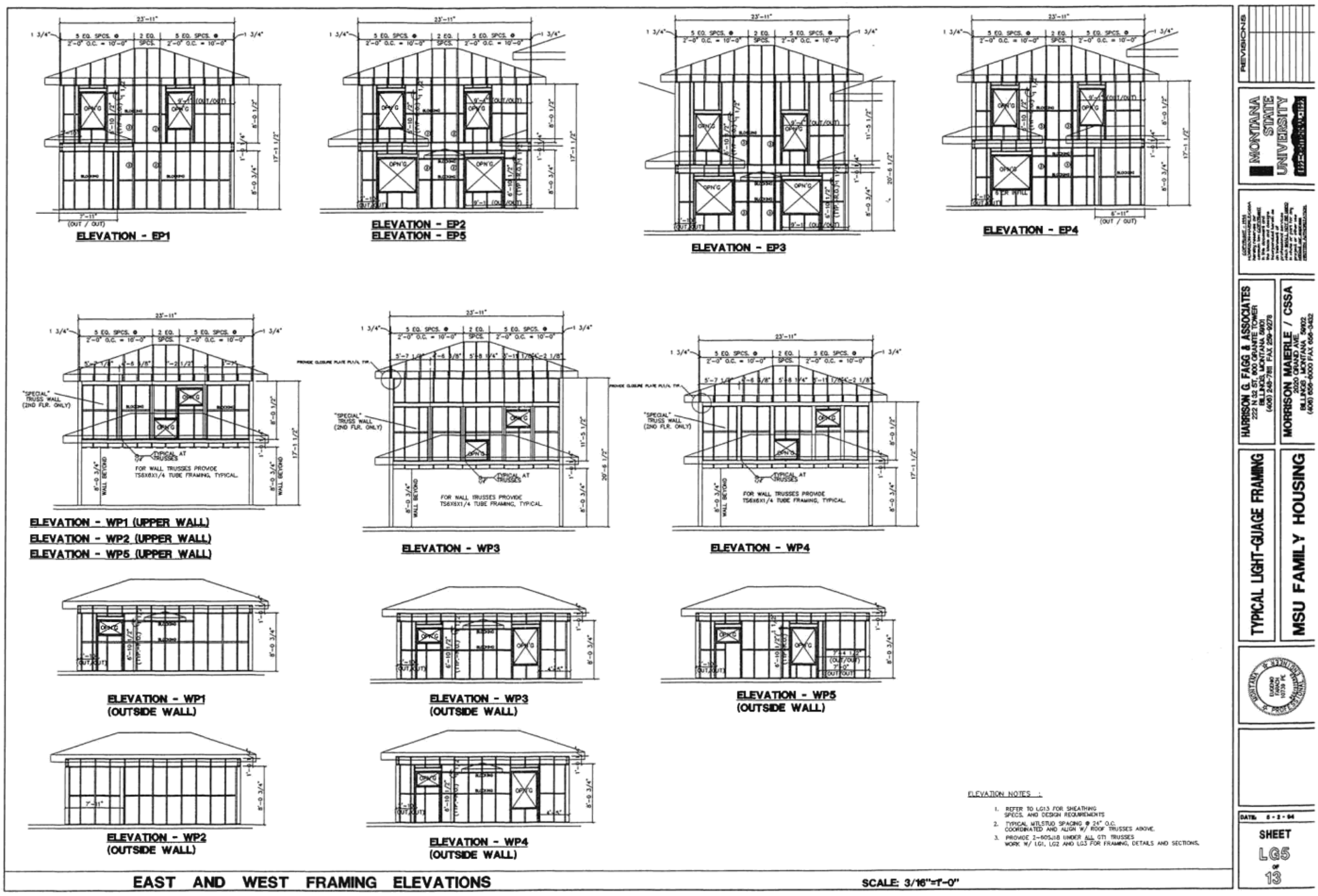
What follows is a sample design of the MSU Family Housing complex for Montana State University in Bozeman, Montana…

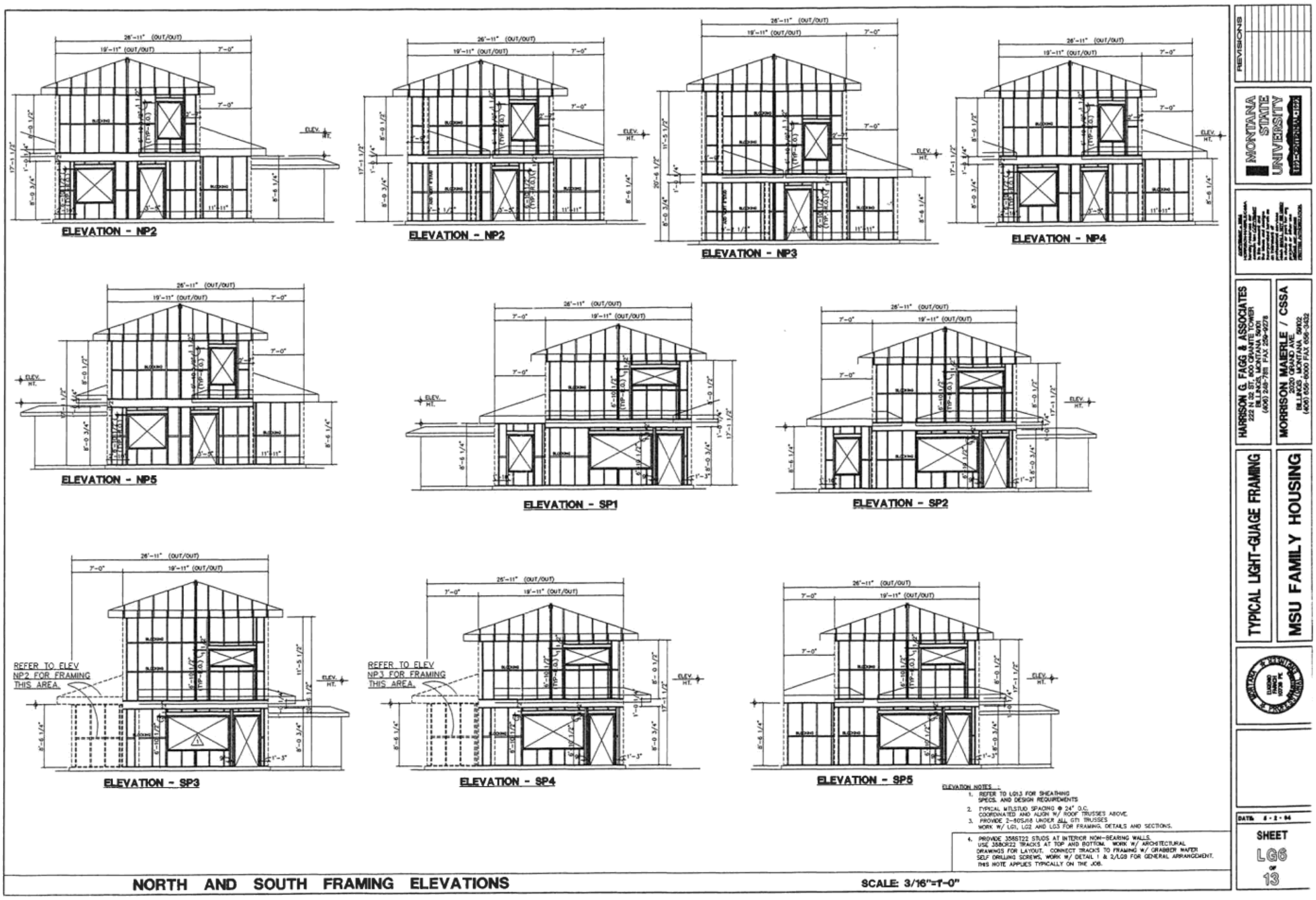

NOTE :
1. COORDINATE ORIENTATION AND LOCATION OF UNIT COMPLEX , PER CIVIL (SITE) AND ARCHITECTS DRAWINGS.
2. ALL DIMENSIONING OF EXTERIOR LIGHT GUAGE FRAMING SHALL CORRESPOND WITH ARCH. DWGS OF UNIT COMPLEX. ALSO REFER TO LIGHT GUAGE ELEVATION SHEETS.
3. FOR LIGHT GUAGE MEMBER – TYPE, SIZE, STYLE, AND GUAGE , REFER TO LIGHT GUAGE STEEL SCHEDULE ON SHT. "LG13"
4. ALL DIMENSIONING OF INTERIOR LIGHT GUAGE FRAMING SHALL CORRESPOND WITH ARCH. DWGS OF UNIT COMPLEX.
5. REFER TO ARCHS. DWGS FOR FRAMING OF WOOD STAIRS AT STAIR 108 (TYP @ ALL UNITS).
6. NP, SP, EP, WP INDICATES DIRECTIONS NORTH, SOUTH, EAST & WEST ELEVATION PLANS – WORK WITH SHTS."LG5 AND LG6".
7. FLOOR JOISTS (11.5SJ18) SHALL BE SPACED AT 24" O.C. MAX. FLOOR JOISTS SHALL ALIGN W/ STUDWALLS & ROOF TRUSSES.
8. PROVIDE MODIFIED HIP JACK TRUSS AND WORK WITH DETAIL #8/LG10 OR #8A/LG10 AT 6" METAL STUD WALLS.
UNIT #1
UNIT #2
UNIT #3
UNIT #4
UNIT #5
FIVE UNIT COMPLEX – SECOND FLOOR PLAN
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
REVISIONS
SHEET
LG2
OF
13

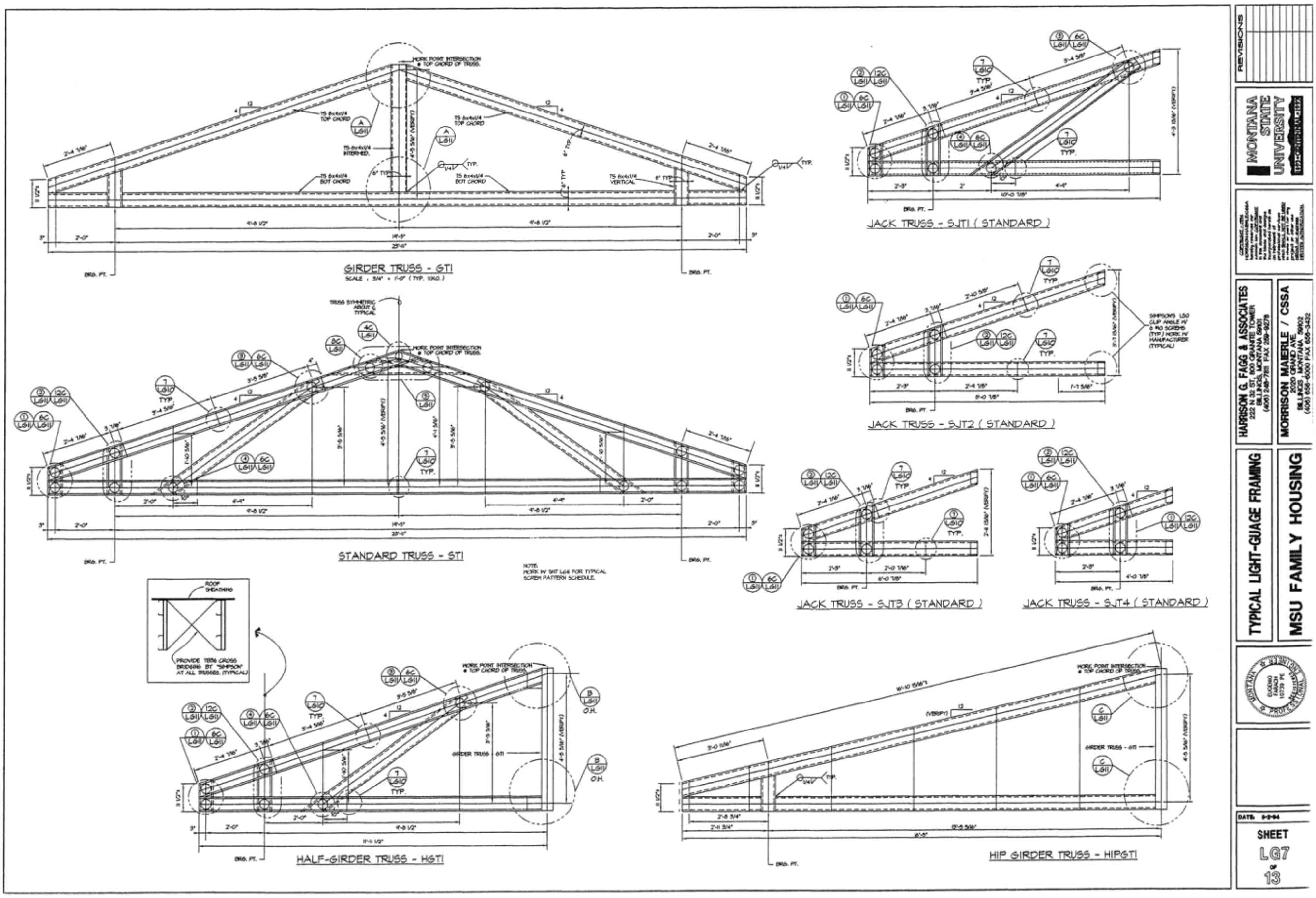


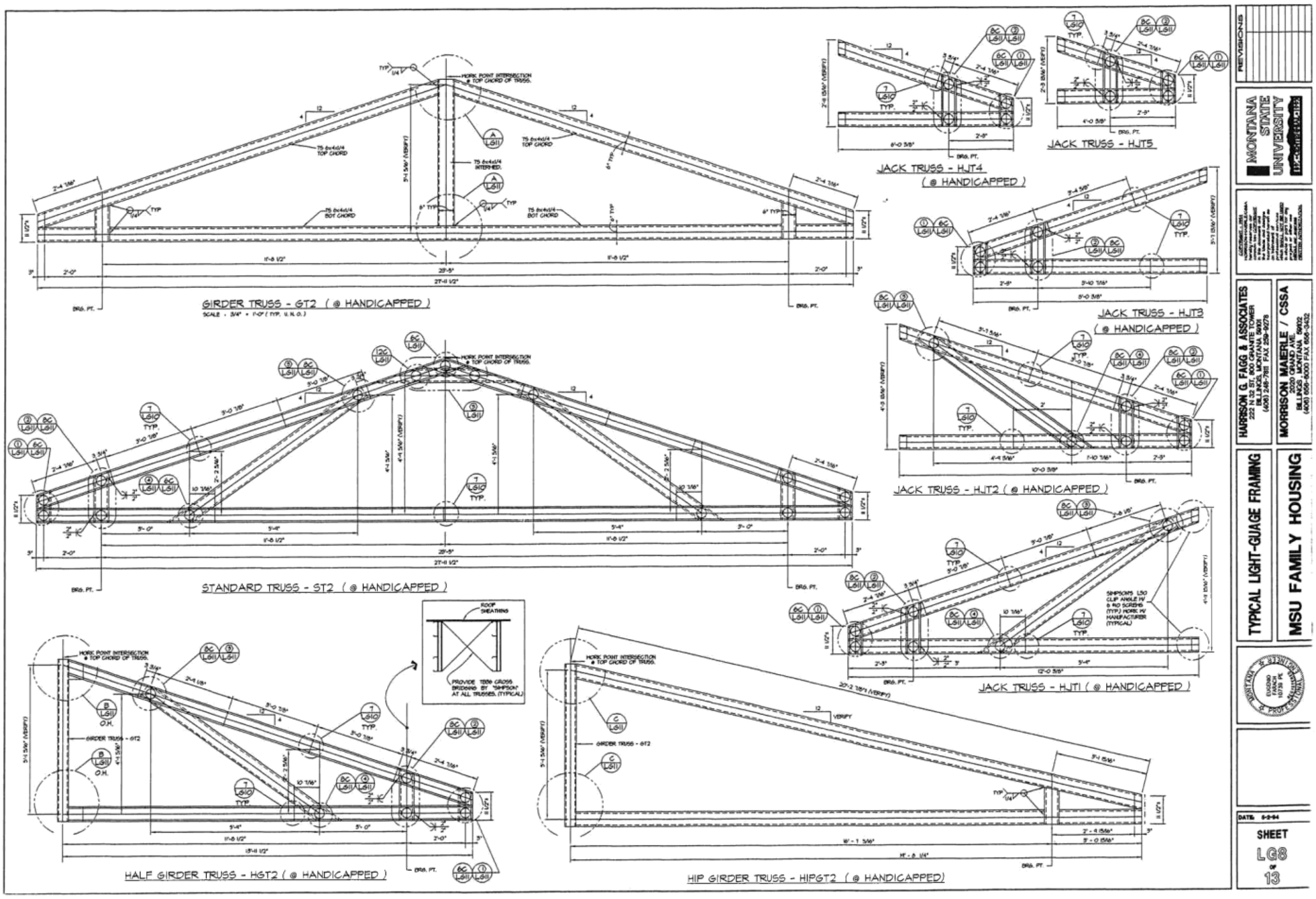
TYPICAL CORNER DETAIL @ CORNERS
NO SCALE
11.5SJ16 @ CORNERS (TYP) RETURN 2 SPCS – SECURE W/"SIMPSON" L70 CONNECTORS
6SJ16 INFILL (TYP)
REFER HERE (TYPICAL)
24'-0" OUT / OUT TYPICAL SPC'G 24" O.C.
NOTE :
1. COORDINATE ORIENTATION AND LOCATION OF UNIT COMPLEX , PER CIVIL (SITE) AND ARCHITECTS DRAWINGS.
2. ALL DIMENSIONING OF EXTERIOR LIGHT GUAGE FRAMING SHALL CORRESPOND WITH ARCH. DWGS OF UNIT COMPLEX. ALSO REFER TO LIGHT GUAGE ELEVATION SHEETS.
3. FOR LIGHT GUAGE MEMBER – TYPE, SIZE, STYLE, AND GUAGE , REFER TO LIGHT GUAGE STEEL SCHEDULE ON SHT. "LG13"
4. FOR LIGHT GUAGE LOWER ROOF FRAMING REFER TO SHT. "LG2" (SECOND FLOOR FRAMING PLAN)
5. LIGHT GUAGE ROOF FRAMING MEMBERS PROFILES ARE SHOWN ON SHTS. "LG7" AND "LG8".
6. USE DETAIL #7 / LG11 FOR BLOCKING ON ROOF FRAMING – SEE SHEETS LG7 AND LG8 FOR LOCATION OF TOP AND BOTTOM CHORDS.
FIVE UNIT COMPLEX – ROOF FRAMING PLAN
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG3
13

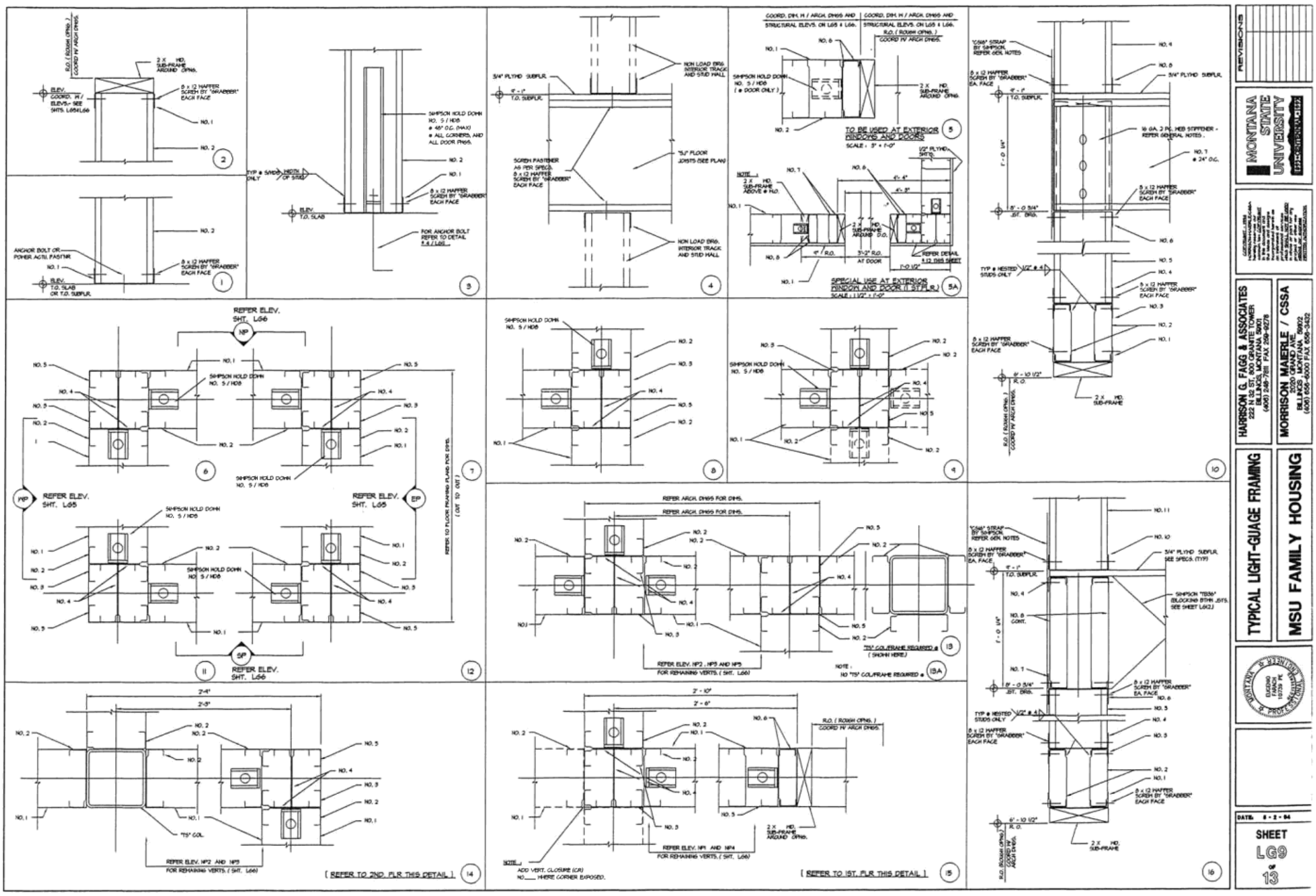

NOTES :
ELEVATION - WHC
ELEVATION - EHC
ELEVATION - NHC
ELEVATION - SHC
FIVE UNIT COMPLEX - HANDICAP UNIT
FIVE UNIT COMPLEX - HANDICAP UNIT - FIRST FLOOR PLAN
HANDICAP UNIT
UNIT #4
TYPICAL CORNER DETAIL @ CORNERS
NO SCALE
FIVE UNIT COMPLEX - HANDICAP UNIT - ROOF FRAMING PLAN
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG4
13

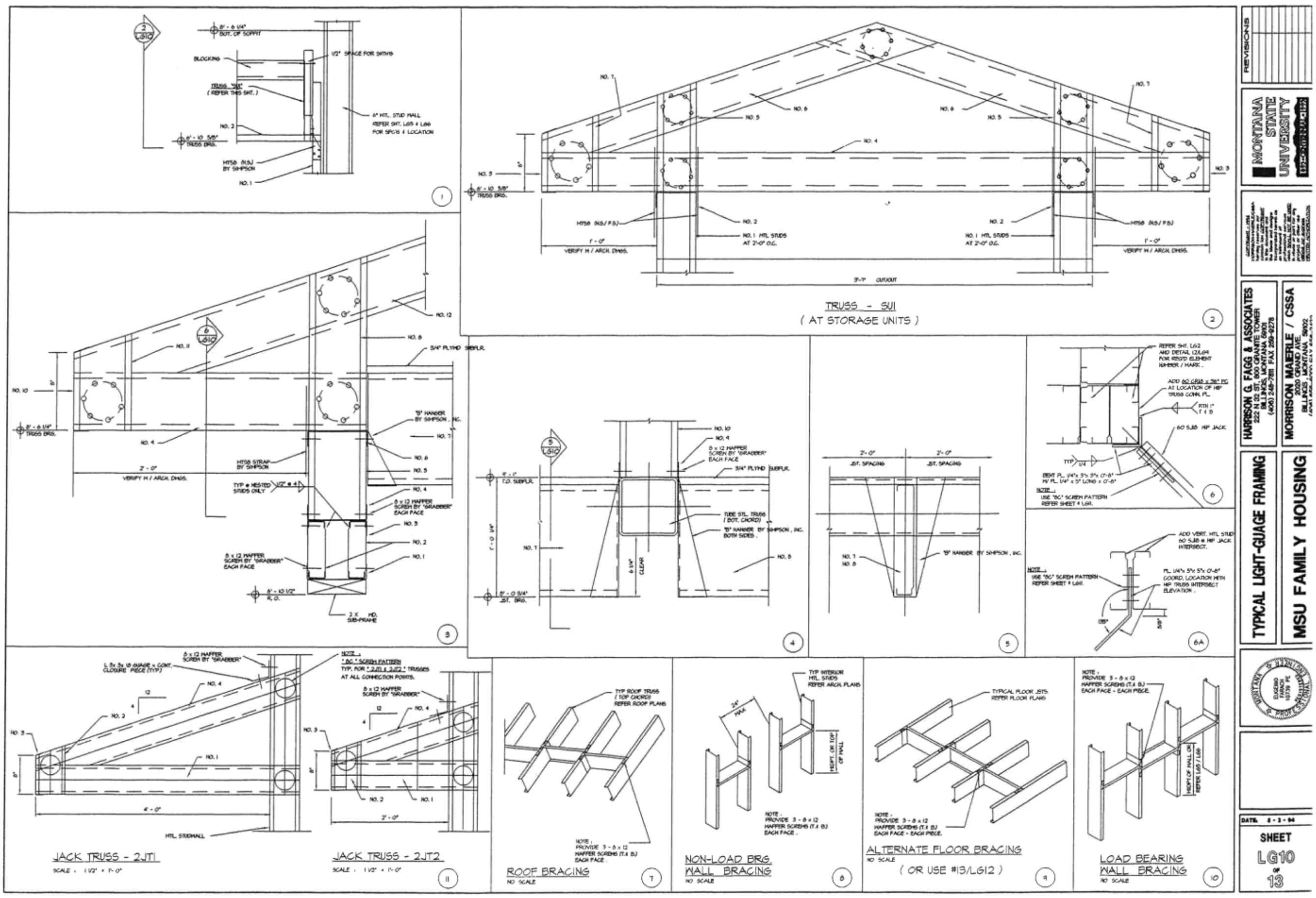

ELEVATION - EP1
ELEVATION - EP2
ELEVATION - EP5
ELEVATION - EP3
ELEVATION - EP4
ELEVATION - WP1 (UPPER WALL)
ELEVATION - WP2 (UPPER WALL)
ELEVATION - WP5 (UPPER WALL)
ELEVATION - WP3
ELEVATION - WP4
ELEVATION - WP1 (OUTSIDE WALL)
ELEVATION - WP3 (OUTSIDE WALL)
ELEVATION - WP5 (OUTSIDE WALL)
ELEVATION - WP2 (OUTSIDE WALL)
ELEVATION - WP4 (OUTSIDE WALL)
EAST AND WEST FRAMING ELEVATIONS
SCALE: 3/16"=1'-0"
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
REVISIONS
SHEET
LG5
13

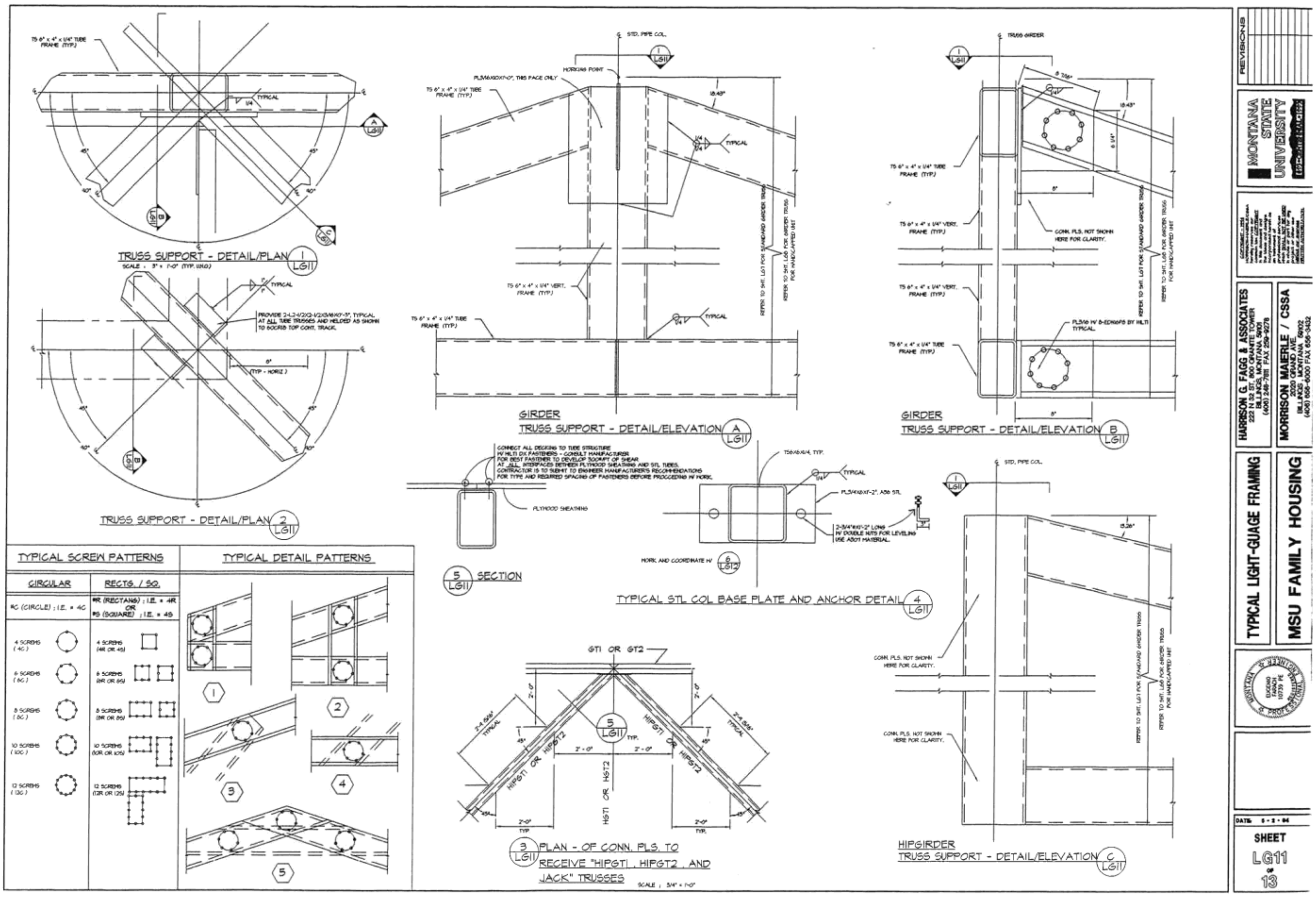

ELEVATION - NP2
ELEVATION - NP2
ELEVATION - NP3
ELEVATION - NP4
ELEVATION - NP5
ELEVATION - SP1
ELEVATION - SP2
ELEVATION - SP3
ELEVATION - SP4
ELEVATION - SP5
NORTH AND SOUTH FRAMING ELEVATIONS
SCALE: 3/16"=1'-0"
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
SHEET
LG6
13

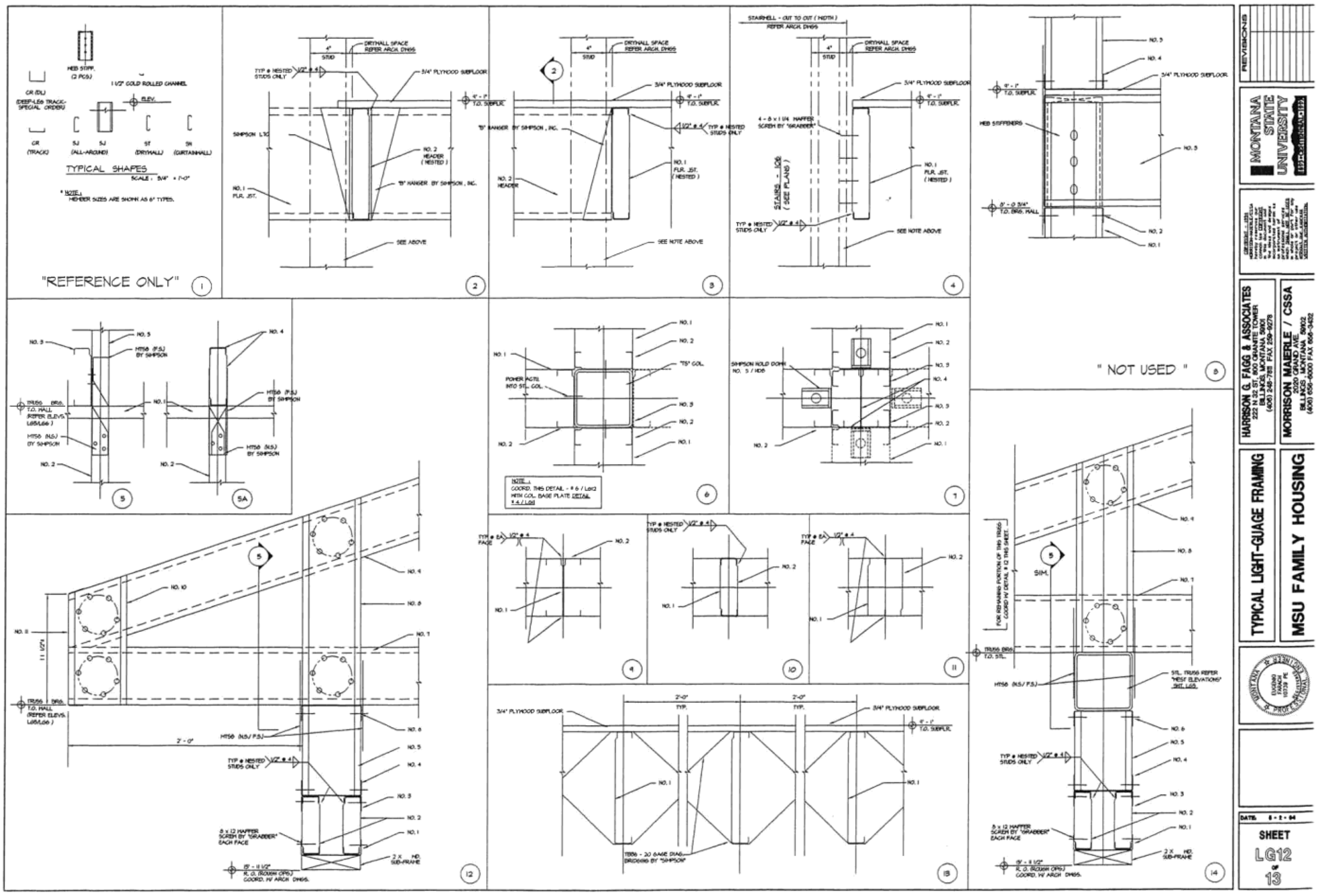

GIRDER TRUSS - GT1
STANDARD TRUSS - ST1
HALF-GIRDER TRUSS - HGT1
HIP GIRDER TRUSS - HIPGT1
JACK TRUSS - SJT1 (STANDARD)
JACK TRUSS - SJT2 (STANDARD)
JACK TRUSS - SJT3 (STANDARD)
JACK TRUSS - SJT4 (STANDARD)
REVISIONS
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG7
13

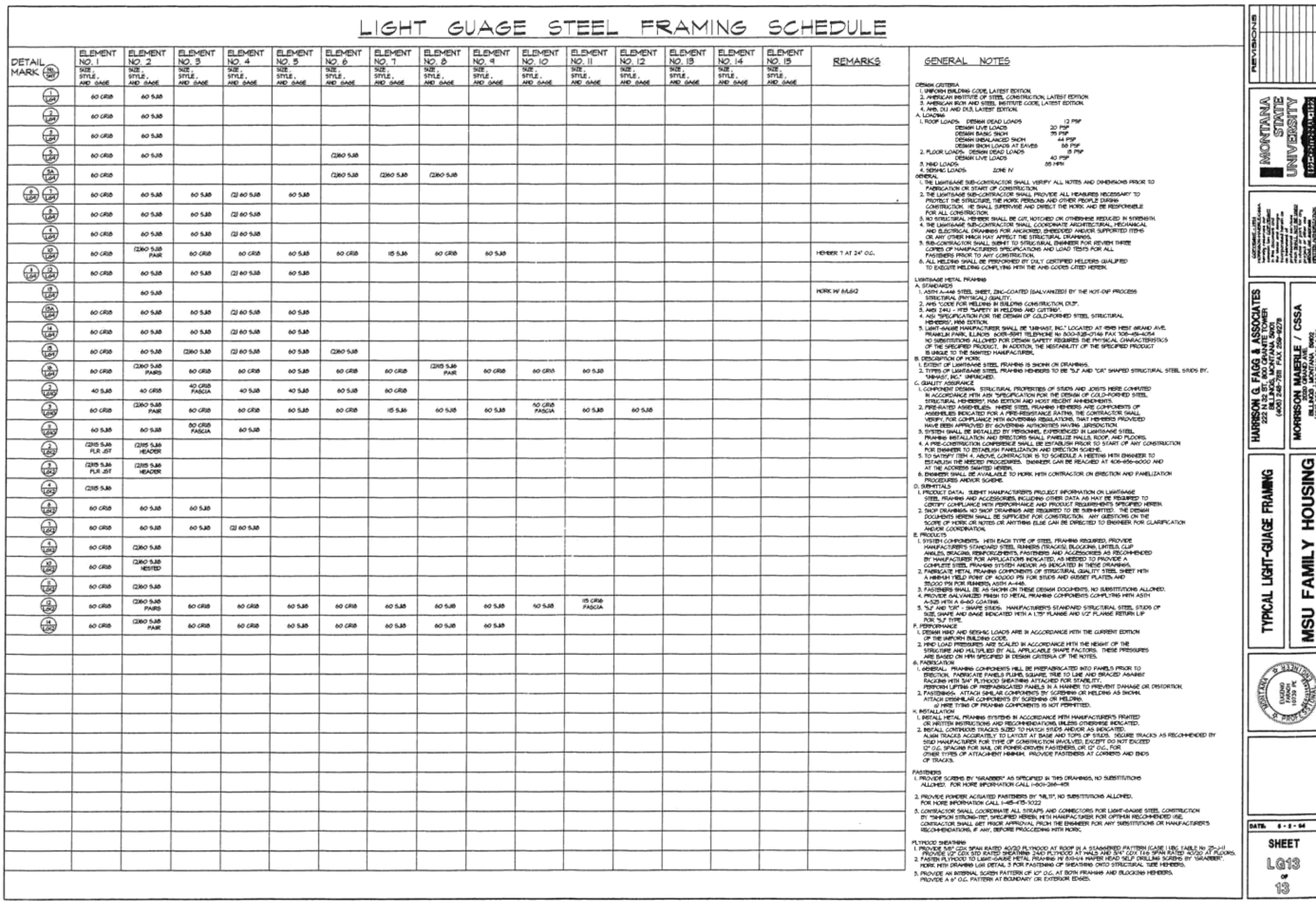

GIRDER TRUSS - GT2 (@ HANDICAPPED)
STANDARD TRUSS - ST2 (@ HANDICAPPED)
HALF GIRDER TRUSS - HGT2 (@ HANDICAPPED)
HIP GIRDER TRUSS - HIPGT2 (@ HANDICAPPED)
JACK TRUSS - HJT4
(@ HANDICAPPED)
JACK TRUSS - HJT5
JACK TRUSS - HJT3
(@ HANDICAPPED)
JACK TRUSS - HJT2 (@ HANDICAPPED)
JACK TRUSS - HJT1 (@ HANDICAPPED)
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG8
13




TRUSS - SU1
(AT STORAGE UNITS)
JACK TRUSS - 2JT1
JACK TRUSS - 2JT2
ROOF BRACING
NON-LOAD BRG. WALL BRACING
ALTERNATE FLOOR BRACING
(OR USE #13/LG12)
LOAD BEARING WALL BRACING
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
MONTANA STATE UNIVERSITY
SHEET
LG10
13


TRUSS SUPPORT - DETAIL/PLAN
TRUSS SUPPORT - DETAIL/PLAN
GIRDER
TRUSS SUPPORT - DETAIL/ELEVATION
GIRDER
TRUSS SUPPORT - DETAIL/ELEVATION
TYPICAL SCREW PATTERNS
TYPICAL DETAIL PATTERNS
SECTION
TYPICAL STL COL BASE PLATE AND ANCHOR DETAIL
PLAN - OF CONN. PLS. TO RECEIVE "HIPGT1, HIPGT2, AND JACK" TRUSSES
HIPGIRDER
TRUSS SUPPORT - DETAIL/ELEVATION
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG11


REVISIONS
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG12
OF
13
TYPICAL SHAPES
"REFERENCE ONLY"
" NOT USED "


LIGHT GUAGE STEEL FRAMING SCHEDULE
REMARKS
GENERAL NOTES
MONTANA STATE UNIVERSITY
HARRISON G. FAGG & ASSOCIATES
MORRISON MAIERLE / CSSA
TYPICAL LIGHT-GUAGE FRAMING
MSU FAMILY HOUSING
SHEET
LG13
of
13