Light Steel Framing Design

Nabil A. Rahman, Ph.D., P.E.
Director of Engineering, The Steel Network, Inc.
nabil@steelnetwork.com
www.steelnetwork.com

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Agenda

Introduction
- History of CFS - Durability and Fire Rating
- Current Specification and Design Standards
- Standard Nomenclature, Thickness and Coating

Mid-Rise Load Bearing Steel Stud Framing
- Wall and Floor Systems
- Wall Sheathing and Mechanical Bracing
- Wall Top & Bottom Tracks
- Shear Walls
- Construction Bracing
- Project Examples

Wind-Bearing (Curtain Wall) Steel Stud Framing
- Infill vs. Bypass Framing
- Curtain Wall Openings
- Wall Sheathing and Mechanical Bracing
- Sliding and Rigid Connections

Light Steel Framing Design Using Software
- Examples for Wind-Bearing and Load-Bearing Cases

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

©2006-17 Applied Science International, LLC

History of Cold-Formed Steel

The use of CFS members in building construction began in the 1850s in both the USA and GB.

One of the first documented uses of CFS as a building material is the Virginia Baptist Hospital, constructed around 1925 in Lynchburg, Virginia.

In the 1940s, Lustron Homes built and sold almost 2,500 steel-framed homes, with the framing, finishes, cabinets and furniture made from CFS.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

History of Cold-Formed Steel

American Iron and Steel Institute

- **American Iron and Steel Institute (AISI) published its 1st edition of the ASD CFS Specification in 1946 (AISI, 1946) based on research work at Cornell University by Prof. George Winter.**
- **The ASD Specification was subsequently revised in 1956, 1960, 1962, 1968, 1980, and 1986.**
- **In 1991, AISI published its 1st edition of the LRFD CFS Specification.**
- **In 2001, AISI published its 1st edition of the North American CFS Specification.**

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Durability of Cold-Formed Steel

Site Location	Sample Material	Sample Location	Mass Loss (Grams)	Exposure Duration (months)	Corrosion Rate[1] (μ/yr)	Estimated Life Expectancy[2] (years)
Hamilton, Ontario	Galvanize 2	Attic	0.013	98	0.0223	841
		Wall	0.020	98	0.0343	547
	Galvalume	Attic	0.017	98	0.0555	554
		Wall	0.020	98	0.0653	471
	Galfan	Attic	0.013	98	0.0238	1,294
		Wall	0.020	98	0.0366	841
Miami, Florida	Galvanize 2	Attic	0.017	99	0.0289	650
	Galvalume		0.013	99	0.0420	732
	Galfan		0.033	99	0.0597	515
Long Beach Island, New Jersey	Galvanize 1	Wall	0.013	87	0.0251	757
		Floor	0.020	87	0.0386	485
		Under Deck	0.030	87	0.0580	324
	Galvalume	Wall	0.013	87	0.0478	643
		Floor	0.027	87	0.0993	310
		Under Deck	0.023	87	0.0846	363
	Galfan	Wall	0.013	87	0.0268	1,149
		Floor	0.040	87	0.0823	373
		Under Deck	0.027	87	0.0556	553

- Durability of Cold-Formed Steel Framing Members Technical Note by the Cold Formed Steel Engineers Institute (CFSEI) at www.cfsei.org.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Fire Rating for Cold-Formed Steel

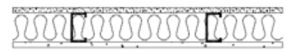
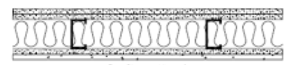
- Fire Ratings of CFS Wall, Floor and Roof Assemblies
- CFS members are non-combustible, and will not supply fuel to a spreading fire. The use of non-combustible material can result in better fire resistance and lower insurance premiums.
- CFS members are required to be fire resistant when they are part of a wall, floor or roof assembly. In some cases, these members can provide a fire rating of up to 4 hours.
- Fire Rating for CFS steel wall, floor and roof assemblies are accomplished using a combination of sheathing and insulation types and thickness tested by the Underwriters Laboratory (UL) and given a specific fire rating in hours. These varying assemblies are typically called UL Assembly Details.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

©2006-17 Applied Science International, LLC

Fire Rating for Cold-Formed Steel

A Guide to Fire & Acoustic Data for Cold-Formed Steel Floor, Wall & Roof Assemblies, Steel Framing Alliance, Feb. 2017

Source	Description	Fire Resistance Rating	Sound Transmission Class
UL U404	• 3 ½" x 20 ga steel studs spaced at 16" o.c. • 3" mineral wool insulation • 1 layer ½" or ⅝" cementitious board on one side • 1 layer ⅝" thick gypsum board on other side	 1 h	<50*
	• 3 ½" x 20 ga steel studs spaced at 16" o.c. • 3" mineral wool insulation • 2 layers ⅝" gypsum board on one side • inner layer of ⅝" thick gypsum, outer layer of ½" or ⅝" cementitious board on other side	 2 h	<50*
	• 3 ½" x 20 ga steel studs spaced at 16" o.c. • 3" mineral wool insulation • 2 layers ½" or ⅝" cementitious board on one side • 2 layers ⅝" thick gypsum board on other side	 2 h	<50*

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Specification and Design Standards

American Iron and Steel Institute

AISI publishes general Design Specification for cold-formed steel members S100-07 for 2012 IBC, S100-12 for 2015 IBC

AISI also publishes Design Standards for CFS Components:

- Floor and Roof System Design S210-07 (2012)
- Wall Stud Design S211-07 w/S1-12 (2012)
- Header Design S212-07 (2012)
- Lateral Design S213-07 w/S1-09 (2012)
- Prescriptive Method S230-07 w/S3-12 (2012)
- Seismic Design – Special Bolted Moment Frames S110-07 w/S1-09 (2012)
- General Provisions S200-12
- Product Data S201-12
- Truss Design S214-12

https://shop.steel.org/

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Specification and Design Standards

Free AISI Standards!

Includes the following:

- S200 Series – 2012 Framing Standards
- S310 - Standard for the Design of Profiled Steel Diaphragm Panels – 2013 Edition
- S900 Series - Test Standards

AISIStandards.org

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Design Guides

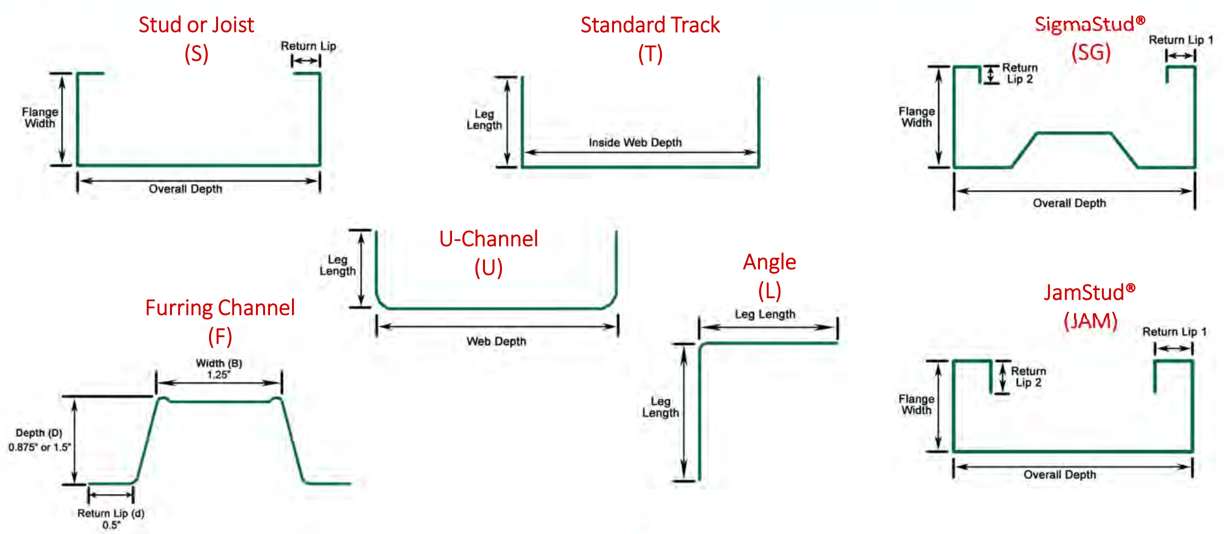
Design Guides and Aids

- AISI D100-13 Cold-Formed Steel Design Manual
- AISI D110-16 Cold-Formed Steel Framing Design Guide
- Brick Veneer Cold-Formed Steel Framing Design Guide - 2013 Edition

https://shop.steel.org/

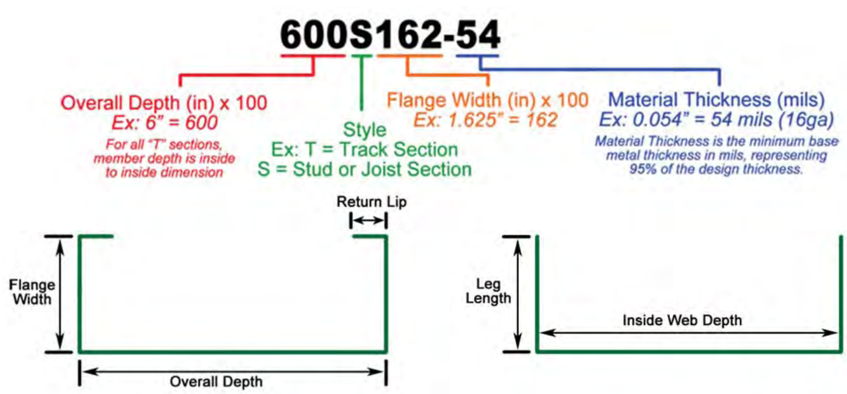
LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Common Cold-Formed Steel Sections



Standard Nomenclature

The industry created a standardized nomenclature for cold-formed steel sections. Each member company is required to label members that are made for easy identification.



Standard Thickness and Coating

Design Thickness	Minimum Base Steel Thickness		Design Thickness	
	(inch)	(mm)	(inch)	(mm)
18	0.0179	0.455	0.0188	0.478
30	0.0296	0.752	0.0312	0.792
33	0.0329	0.836	0.0346	0.879
43	0.0428	1.087	0.0451	1.146
54	0.0538	1.367	0.0566	1.438
68	0.0677	1.720	0.0713	1.811
97	0.0966	2.454	0.1017	2.583
118	0.1180	2.997	0.1242	3.155

Coating Weight [Mass] Requirements (Metallic Coatings)	
Material Designation	Coating Designation
Type H and Type L	G60 [Z180][A] A60 [ZF180][B] AZ50 [AZM150][C]
Type NS	G40 [Z120][A] A40 [ZF120][B] AZ50 [AZM150][C]

- ASTM A1003: Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Cold-Formed Steel Framing

Cold-Formed Steel Framing as Secondary or Primary Framing of a Building.

Load Bearing Wall Application

Curtain Wall Application

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Components of Load Bearing System

Walls to Support Gravity Loads:

- Studs typically spaced @ 16" o.c. (in some cases 12" or 24" o.c.)
- Top and bottom track, fully seating studs (thickness per design)
- Stud bracing (Bridging) @ 4' to 5' o.c. with bridging anchorage
- Shear walls (X-bracing or shear panels)
- Temporary construction bracing

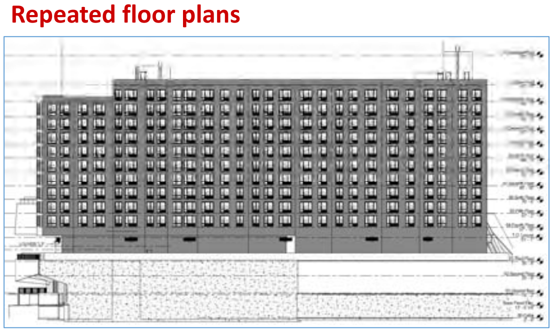
Floor/Roof System:

- Selected based on clear span
- Diaphragm system for lateral shear distribution to shear walls
- Positive attachment with load bearing walls

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Understanding Projects that Benefit

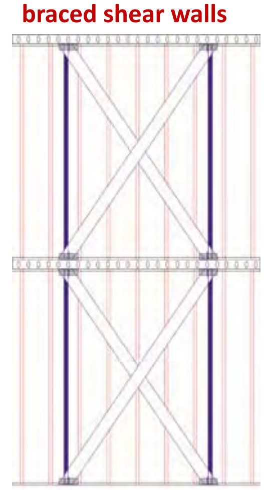
Repeated floor plans



Spans typically less than 30 feet

Old Dominion University Quad Housing - Norfolk, VA

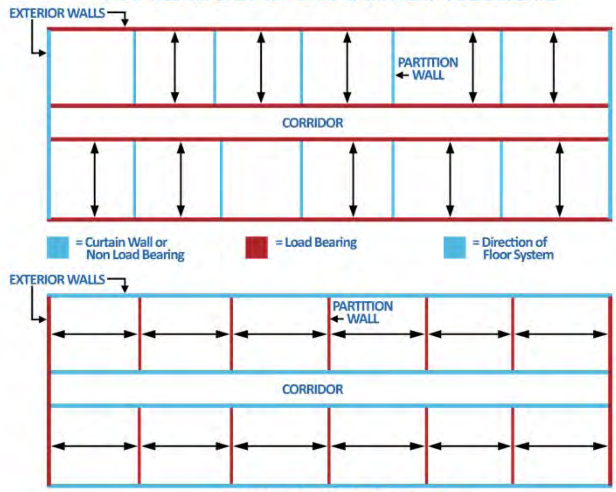
Stacked vertical lateral braced shear walls



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Floor/Wall System Layouts

TYPICAL LOAD BEARING PROJECTS



PLAN VIEW - TYPICAL FLOOR

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

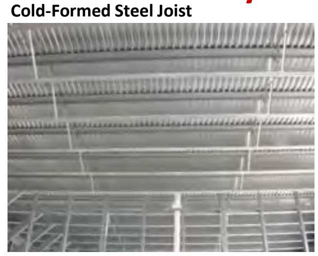
Floor System Types

Compatible With All Common Floor Systems

Pre-Cast Hollowcore Slab

- Typically the most economical system
- Precast Unit
- Begin M-E-P rough-in faster
- Typically frame one floor per week
- Erect in poor weather conditions
- Clear spans greater than 30’ are possible

Cold-Formed Steel Joist



- Lightest Floor System
- Reduces bearing weight on studs
- Comparable material cost with Hollowcore plank
- One trade to install floor & wall systems

Composite Steel Deck

- No camber
- Flexible designs with larger clear spans (less than H/C plank)
- Meets UL life-safety & STC requirements
- Simplified connection to the structural wall

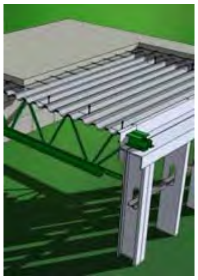
Composite Bar Joist

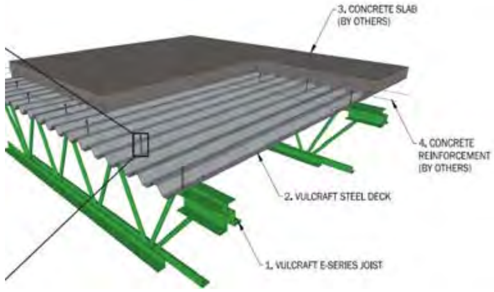
- Longer spans provide design flexibility
- No shoring
- Plenums for mechanical chase
- Reduced mass of structure

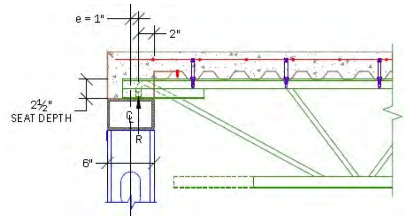
LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Floor Systems

Composite Joist/Concrete Deck







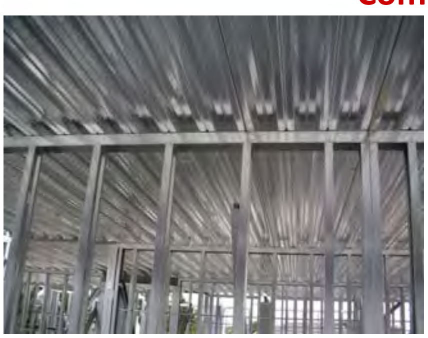
Seat Reaction Location with 2½" depth on CFS

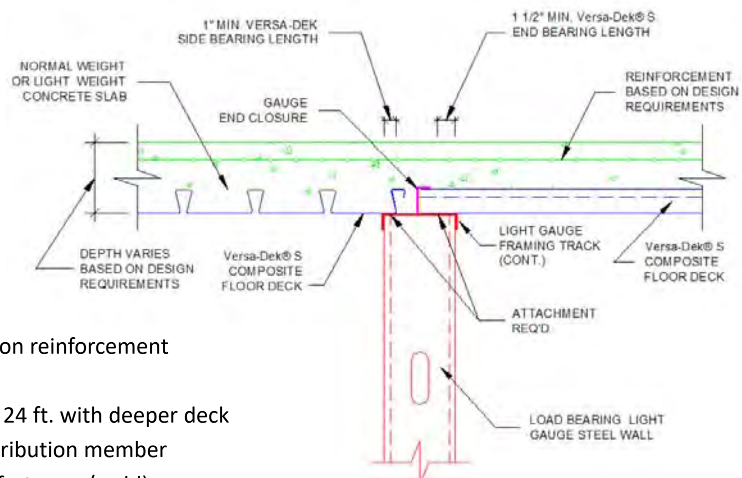
- Joists ranging from 10" to 24" deep and a maximum span length of approximately 50'-0". Joists are typically spaced at 4'-0" o.c.
- Deck provides permanent form and tension reinforcement
- Concrete slab thickness typically 2½" on top of deck, NWC

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Floor Systems

Composite Joist/Concrete Deck





- Deck provides permanent form and tension reinforcement
- Typically requires shoring
- Typical clear spans 13-16 ft. Can go up to 24 ft. with deeper deck
- Top track to be designed as a flexural distribution member
- Positive connection is needed with wall (fasteners/weld)

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Floor Systems

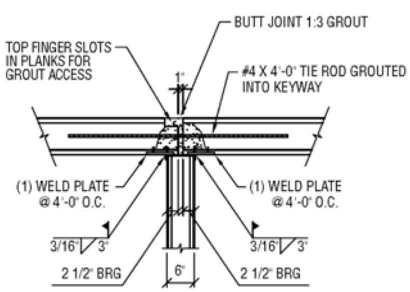
Precast Hollowcore Plank

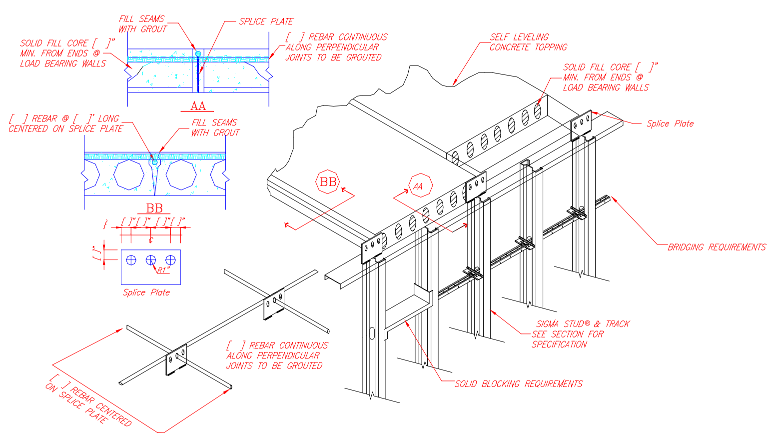
- High stiffness-to-weight ratio
- Installation rate up to 5,000 sq.ft./day
- Available depth 6”, 8”, 10”, 12”, and 16”
- Spans up to 22 ft. for 6” planks and 30 ft. for 8” planks
- Sufficient bearing required (minimum 2.5” bearing)
- Positive connection is needed with wall (embedded plate or key-way plate)

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Floor Systems

Precast Hollowcore Plank

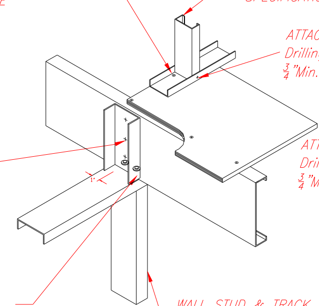




LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Floor Systems

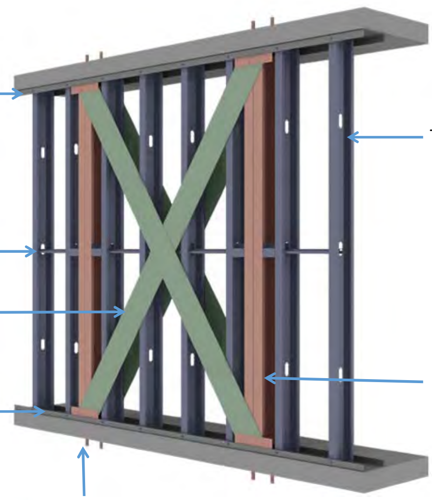
CFS Joists



- Spans up to 30 ft. with 16” deep joists
- Connects to stud wall through rim tracks
- Web stiffeners needed at supports
- Lateral bracing (Blocking) needed every 8 to 10 ft.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Wall Framing



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Wall Stud Bracing

North American Standard for Cold-Formed Steel Framing – Wall Stud Design (AISI S211)

Sheathing Braced Design

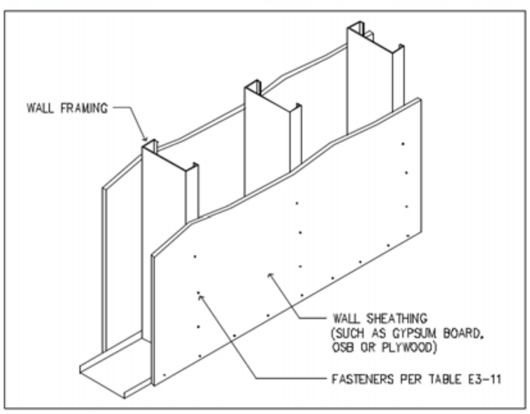
- Sheathing provides structural contribution to brace wall studs
- Section B - AISI S211

All Steel Design

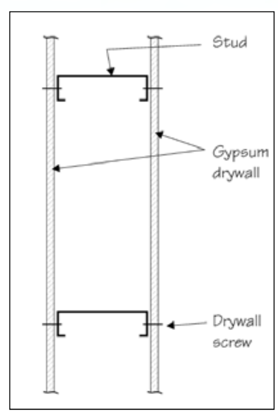
- Wall Stud Assemblies shall be designed neglecting the structural contribution of the attached sheathing
- Section D 4.1 – AISI S100

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Wall Studs – Sheathing Bracing



From AISI D110



From AISI D110

Stud Bracing with Sheathing Material Only

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

©2006-17 Applied Science International, LLC

Wall Studs – Sheathing Bracing

AISI 211-07 – Section B1 (b)

- Identical Sheathing attached to both sides of wall
  - If not identical, use the weaker of the two sheathings for the design
- Sheathing attached to bottom and top horizontal members of wall
- Wall Studs shall be evaluated w/o sheathing for
  1.2 D + (0.5L or 0.2S) + 0.2 W

Where:

D – Dead Load **L – Live Load**

S – Snow Load **W – Wind Load**

Wall Studs – Sheathing Bracing

Axial Load – Section B1.2 (b)

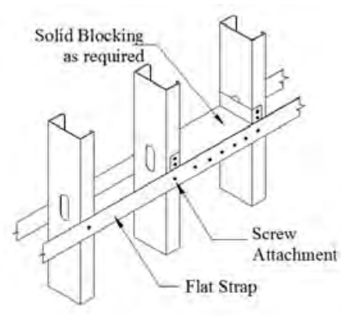
- Axial Strength – C4 of AISI S100
  - L_x = Distance between end supports
  - L_y & L_t = 2 * Distance between sheathing connectors
  - K_x, K_y, K_t = 1.0
- Maximum axial nominal load limited by gypsum sheathing-to-wall stud connection capacity (Table B1-1)

Gyp. Sheathing	Screw Size	Max. Nominal Stud Axial Load (lbs)
½"	#6	5,800
½"	#8	6,700
⅝"	#6	6,800
⅝"	#8	7,800

Wall Studs - All Steel Bracing

Tension-Compression Systems

- Compression Systems
  - Regardless of the type of bridging system used, the bridging must be effectively continuous between anchorage points.
- Face Mounted Straps
- Designed to resist stud buckling by means of pure tension
- Good for mechanical and electrical utilities inside the wall
- Needs access to both sides of the wall
- Flat straps must be installed tight



From TN W400

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Wall Studs - All Steel Bracing

Tension-Compression Systems

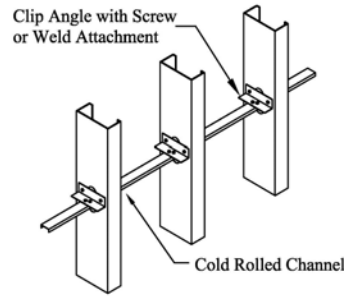
- Face Mounted Straps

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Wall Studs - All Steel Bracing

Tension-Compression Systems

- Channel bridging with a clip
- Standard channel 150U50-54, 33ksi
- Secured to stud by clip angle
- Requires access to only one side of the stud wall.
- Stud punch-outs must align horizontally



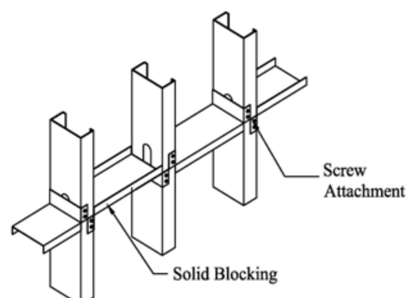
From TN W400

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

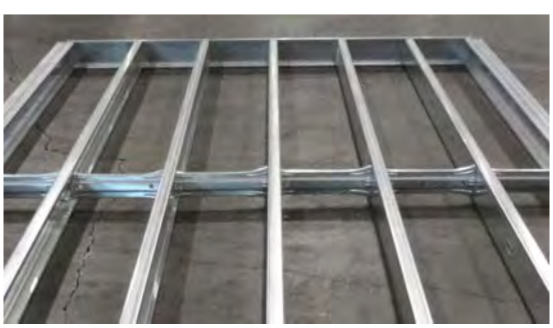
Wall Studs - All Steel Bracing

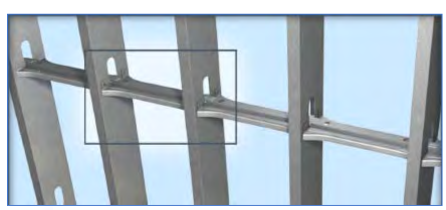
Tension-Compression Systems

- Continuous blocking
- Designed to resist stud buckling by means of full compression, little tension from screws
- Offers higher brace stiffness compared to the tension and the tension-compression bridging systems



From TN W400





LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Bracing – All Steel Design (Axial)

AISI S100-12, Section D3.3, Strength and Stiffness Approach

The required brace strength [resistance] acting on the brace shall be calculated as follows:

Prb = 0.01 Pra (Eq. D3.3-1)

Prb = Required brace strength (brace force) to brace a single compression member with an axial load Pra

Pra = Required compressive axial strength [compressive axial force] of individual concentrically loaded compression member to be braced

Axial Bracing – AISI S100 Section D3.3, Strength and Stiffness Approach

The required brace stiffness for ASD design method is given as:

βrb = $\frac{2[4-(2/n)]}{L_b}(\frac{P_{ra}}{\phi})$ Ω = 2.0 (Eq. D3.3-2a)

While the required brace stiffness for LRFD design methods is given as:

βrb = $\frac{2[4-(2/n)]}{L_b}(\Omega P_{ra})$ φ = 0.75 (Eq. D3.3-2b)

Axial Bracing – AISI S100 Section D3.3, Strength and Stiffness Approach

βrb = Minimum required brace stiffness to brace a single compression member

Pra = Required compressive axial strength [compressive axial force] of individual concentrically loaded compression member to be braced

n = Number of equally spaced intermediate brace locations

Lb = Distance between braces on individual concentrically loaded compression member to be braced

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Bracing – All Steel Design (Axial)

Axial Bracing – AISI S100 Section D3.3, Strength and Stiffness Approach

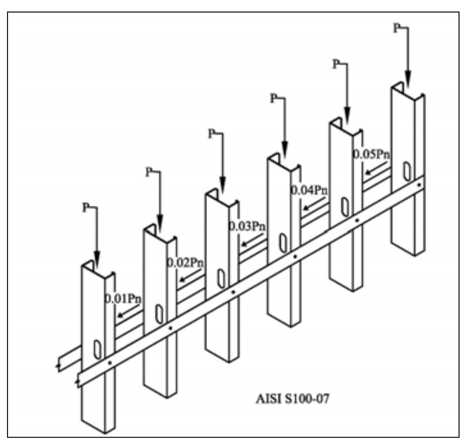
- 1% Force Accumulates
- Linearly, plus Stiffness
- Requirement

AISI S211, Section B3.1 Strength Only Approach

For axial loaded members, each intermediate brace shall be designed for 2% of the design compression force in the member.

Prb = 0.02 Pra (No Equation #)

No explicit brace stiffness requirement.



From TN W400

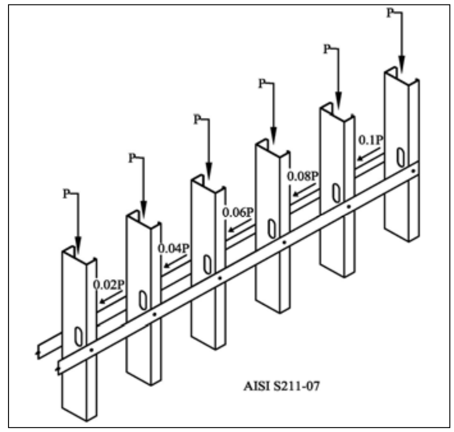
LIGHTER BETTER FASTER STRONGER TRAINING SERIES

©2006-17 Applied Science International, LLC

Bracing – All Steel Design (Axial)

Axial Bracing S211, Section B3.1 Strength Only Approach

- 2% Force Accumulates
- Linearly, No Stiffness
- Requirement

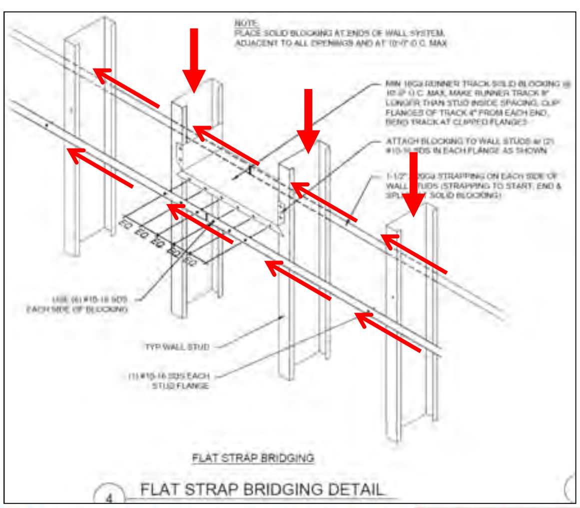


From TN W400

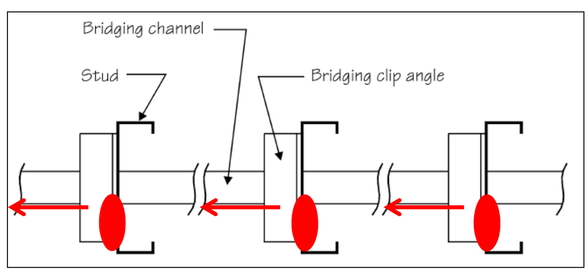
LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Bracing – All Steel Design (Axial)

Face-Mounted Straps (Anchorage Needed)



Through Punch-Out Bridging (Anchorage Needed)

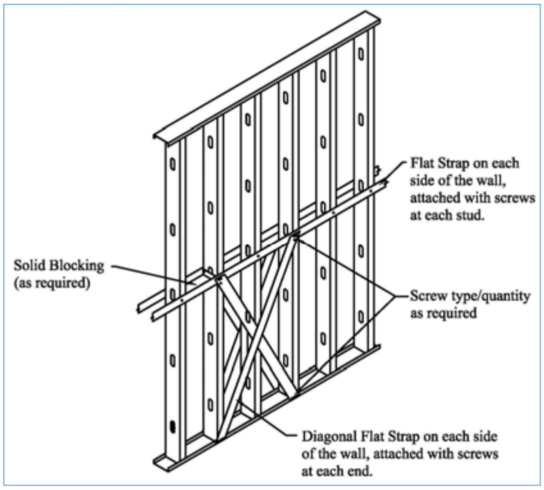


From AISI D110

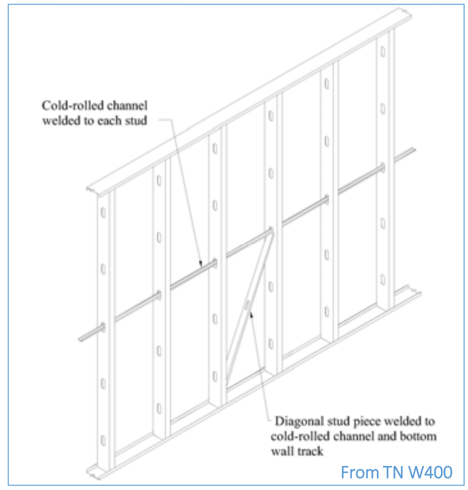
Courtesy of FDR Engineers

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Anchorage Methods



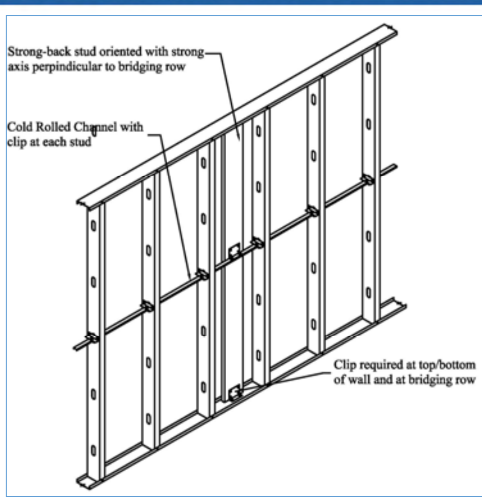
Flat strap cross bracing attached from the bridging line to the bottom of the wall on each side of the studs



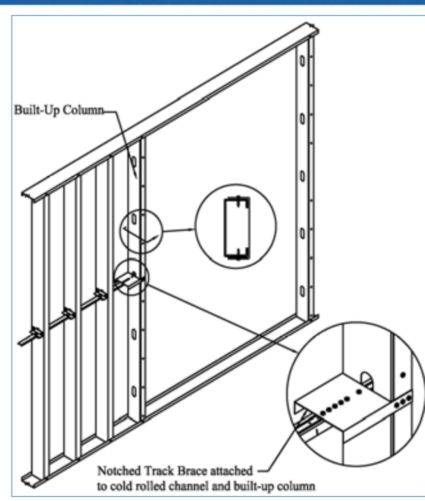
Diagonal piece of a stud or track welded to the bridging line and to the bottom track

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Anchorage Methods



Strong-back stud oriented with strong axis perpendicular to the bridging row and attached to bridging line and top/bottom of wall.



Built-up stud section placed at specific intervals along the wall length with bridging connected to it.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Design of Wall Tracks

Top and bottom track of a load bearing stud should be designed to distribute the axial load across an acceptable bearing surface of concrete.

Typical rule of thumb to achieve acceptable load distribution is to require the same track thickness as the load bearing studs, but no less than 54mil track.

A method of calculating the required track thickness is presented in the AISI Cold Formed Steel Framing Design Guide, Appendix F.

Calculation of the required track width for concrete bearing per method presented in AISI D110-16, Appendix F:

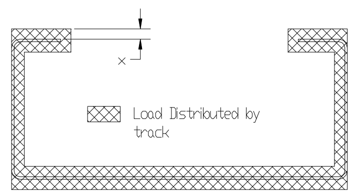
$$M_{req} = \frac{0.35 f_c' x^2}{2} \quad \text{(ASD)}$$

x, width of track that can cantilever beyond the face of the stud

$$M_{all} = \frac{Z F_y}{\Omega}$$

Z = plastic section modulus of track = (1/4)bt^2
b = 1”

$M_{all} = M_{req}$ gives $x = 0.925 t_t \sqrt{\frac{F_y}{f_c'}}$

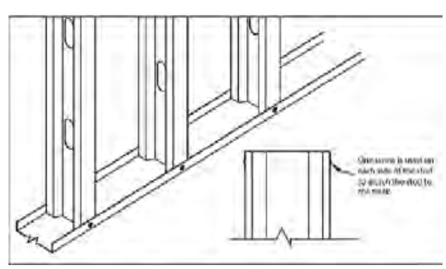


LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Stud-Track Connection

AISI S200 General Provisions:

- Stud seated tight against track
- 1/8” maximum gap between the end of wall framing and the track
- For thickness of stud or track > 54mil, 1/16” max. gap is desirable
- For wind-bearing only framing, ¼” max. gap is allowed
- Typical stud to track attachment is a single screw or tack weld on each flange of the stud

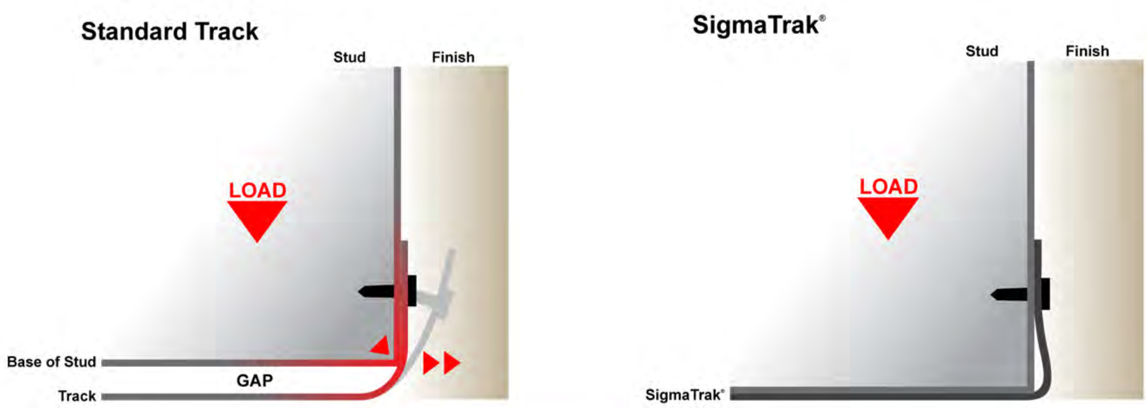


LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Stud-Track Connection

SigmaTrak® web is oversized to allow the stud to seat fully in the track

Eliminates the gap between the stud and the track as a result of bearing on corner radii



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls

North American Standard for Cold-Formed Steel Framing – Lateral Design (AISI S213)

- Requirements for Shear Walls Sheathed with:
  - Gypsum Wallboard
  - Plywood
  - OSB
  - Sheet Steel
- Design Requirements for:
  - Type I Shear Walls
  - Type II Shear Walls
  - Diagonal Strap Bracing

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls

- **ASCE 7-10 for bearing wall systems**
- **Additional requirements in AISI S213 Standard**

MINIMUM DESIGN LOADS

Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R^a	Overstrength Factor, Ω_0^g	Deflection Amplification Factor, C_d^b	Structural System Limitations Including Structural Height, h_n (ft) Limits[c] — Seismic Design Category B	C	D^d	E^d	F^e
A. BEARING WALL SYSTEMS									
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance or steel sheets	14.1 and 14.5	6½	3	4	NL	NL	65	65	65
16. Light-frame (cold-formed steel) walls sheathed with wood structural panels rated for shear resistance or steel sheets	14.1	6½	3	4	NL	NL	65	65	65
17. Light-frame walls with shear panels of all other materials	14.1 and 14.5	2	2½	2	NL	NL	35	NP	NP
18. Light-frame (cold-formed steel) wall systems using flat strap bracing	14.1	4	2	3½	NL	NL	65	65	65

From ASCE7-10

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

Type I Shear Wall (AISI S213 Section C2)

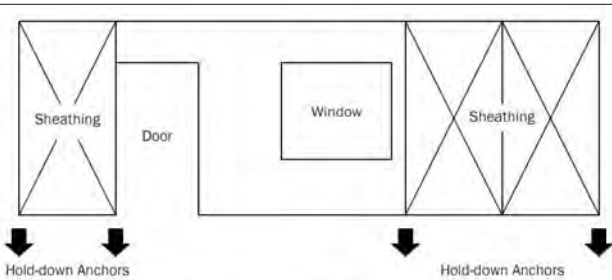


Figure C2-1(a) – Type I Shear Walls Without Detailing for Force Transfer Around Openings

From AISI S213

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

Type II Shear Wall (AISI S213 Section C3)

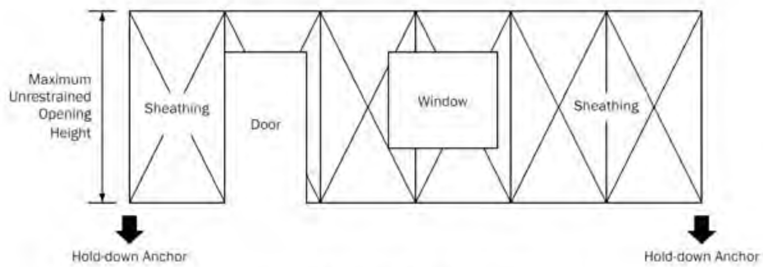


Figure C3-1 – Typical Type II Shear Wall

From AISI S213

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

Table C2.1-1
United States and Mexico
Nominal Shear Strength (R_n) for Wind and Other In-Plane Loads for Shear Walls [1,4,6,7,8]
(Pounds Per Foot)

Assembly Description	Maximum Aspect Ratio (h/w)	Fastener Spacing at Panel Edges[2] (inches)			
		6	4	3	2
15/32" structural 1 sheathing (4-ply), one side	2:1	1065 [3]	-	-	-
7/16" rated sheathing (OSB), one side	2:1	910 [3]	1410	1735	1910
7/16" rated sheathing (OSB), one side oriented perpendicular to framing	2:1	1020	-	-	-
7/16" rated sheathing (OSB), one side	2:1 [5]	-	1025	1425	1825
0.018" steel sheet, one side	2:1	485	-	-	-
0.027" steel sheet, one side	4:1	-	1,000 [9]	1085 [9]	1170 [9]
0.027" steel sheet, one side	2:1 [5]	647	710	778	845

From AISI S213

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

Table C2.1-2
United States and Mexico
Nominal Shear Strength (R_n) for Wind and Seismic Loads for Shear Walls Faced with Gypsum Board or Fiberboard [1,2,3,4]
(Pounds Per Foot)

Assembly Description	Maximum Aspect Ratio (h/w)	Fastener Spacing at Panel Edges/Field (inches)						
		7/7	4/4	4/12	8/12	4/6	3/6	2/6
½" gypsum board on one side of wall; studs max. 24" o.c.	2:1	290	425	295	230	-	-	-
½" fiberboard on one side of wall; studs max. 24" o.c.	1:1	-	-	-	-	425	615	670

From AISI S213

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

Table C2.1-3
United States and Mexico
Nominal Shear Strength (R_n) for Seismic and Other In-Plane Loads for Shear Walls [1,4,7,8]
(Pounds Per Foot)

Assembly Description	Max. Aspect Ratio (h/w)	Fastener Spacing at Panel Edges[2] (inches)				Designation Thickness[5,6] of Stud, Track and Blocking (mils)	Required Sheathing Screw Size
		6	4	3	2		
15/32" Structural 1 sheathing (4-ply), one side	2:1[3]	780	990	-	-	33 or 43	8
	2:1	890	1330	1775	2190	43 or 54	8
						68	10
7/16" OSB, one side	2:1[3]	700	915	-	-	33	8
	2:1[3]	825	1235	1545	2060	43 or 54	8
	2:1	940	1410	1760	2350	54	8
	2:1	1232	1848	2310	3080	68	10
0.018" steel sheet, one side	2:1	390	-	-	-	33 (min.)	8
0.027" steel sheet, one side	4:1	-	1000	1085	1170	43 (min.)	8
	2:1[3]	647	710	778	845	33 (min.)	8

From AISI S213

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

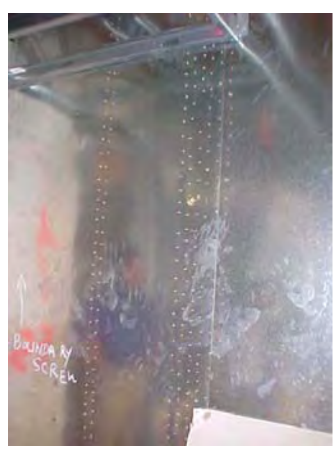
Key Design Requirements, AISI S213

- **Special Seismic Requirements**
  - Section C1.1 - For Seismic Design Categories A-C, an R value of 3 may be used and none of the special seismic requirements need to be met, or an R > 3 may be used and the special seismic requirements must be met. For Seismic Design categories D-F, designer does not have the option to choose R of 3.
  - Section C5.1.1.1 – The available strength of connections for boundary members and collectors shall exceed the nominal tensile strength of the member, but need not exceed the Amplified seismic load.
  - Section C5.1.2.2:- Studs or other vertical boundary members and uplift anchorage thereto shall have the nominal strength to resist loads that the system can deliver, but need not exceed the Amplified seismic load.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Sheathing Bracing

- Fasteners at each intermediate stud
- Fasteners at boundary members



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

©2006-17 Applied Science International, LLC

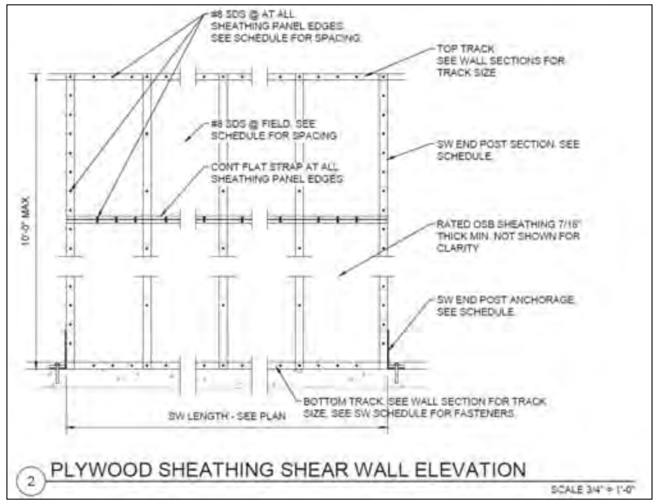
Shear Walls – Sheathing Bracing

SHEARWALL SCHEDULE								
SW TYPE	LAYERS OF SHEATHING	SCREW SPACING		HOLDOWN		HOLDOWN POST # OF STUDS	BOTTOM TRACK ANCHORS	
		EDGE	FIELD	CLIP	ANCHOR EMBEDMENT		SIZE	SPACING
SW1	1	#8 SDS/ 6"oc	#8 SDS/ 12"oc	CLBD0-118(?) w/ (10) #12-14 SDS	SEE [illegible] ANCHOR SCHEDULE	(1) [illegible]	0.157" DIA. X-U PAFs	(2) @ 12"
SW2	1	#8 SDS/ 6"oc	#8 SDS/ 12"oc	CLBD0-118(H) w/ (10) #12-14 SDS		(1) [illegible]	ANCHORS PER SCHEDULE	(1) @ 16"
SW3	1	#8 SDS/ 6"oc	#8 SDS/ 12"oc	CLBD0-118(?) w/ (10) #12-14 SDS		(1) [illegible]	0.157" DIA. X-U PAFs	(2) @ 12"

NOTES:

1. ALL SHEATHING SHALL BE 7/16" THICK RATED OSB OR PLYWOOD.
2. ALL SHEATHING MUST BE INSTALLED HORIZONTALLY WITH THE LONG DIMENSION ACROSS THE STUDS.
3. SCREW SHEATHING TO EACH HOLDOWN STUD W/ SPECIFIED EDGE SCREW PATTERN.

Courtesy of FDR Engineers

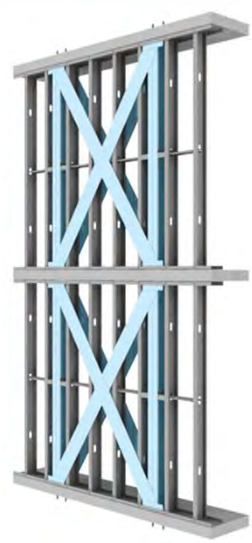


LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Strap Bracing

Diagonal Strap Bracing (AISI S213 Section C4)

Courtesy of the Steel Network, Inc.



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Shear Walls – Strap Bracing

Key Design Requirements, AISI S213

Standard Requirements

- Section C4.1 – The aspect ratio (height/width) of a shear wall with diagonal strap bracing shall not exceed 2:1 unless a rational analysis is performed.

Special Seismic Requirements

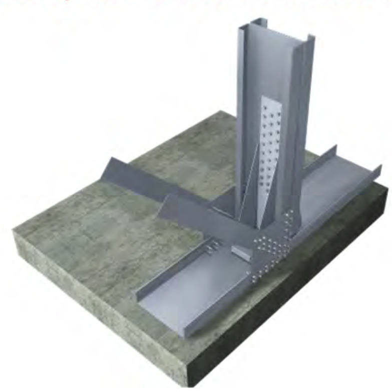
- Section C1.1 - For Seismic Design Categories A-C, an R value of 3 may be used and none of the special seismic requirements need to be met, or an R > 3 may be used and the special seismic requirements must be met. For Seismic Design categories D-F, designer does not have the option to choose R of 3.
- Section C5.2.1.1 – The available strength of connections for diagonal strap bracing members, boundary members and collectors shall exceed the expected yield strength of the diagonal strap bracing member, except the available strength need not exceed the Amplified seismic load.
- Section C5.2.1.2 - The pull-out resistance of screws shall not be used to resist seismic forces.
- Section C5.2.2.2:- All members in the load path and uplift and shear anchorage thereto from the diagonal strap bracing member to the foundation shall have the nominal strength to resist the expected yield strength of the diagonal strap bracing member(s), except the nominal strength need not exceed the Amplified seismic load.

Shear Walls – Strap Bracing

- **No bump-outs at corners**
- **Delivered as a column-boot-assembly**

Back-to-back columns required

Load transferred through track (must upsize track as a result)

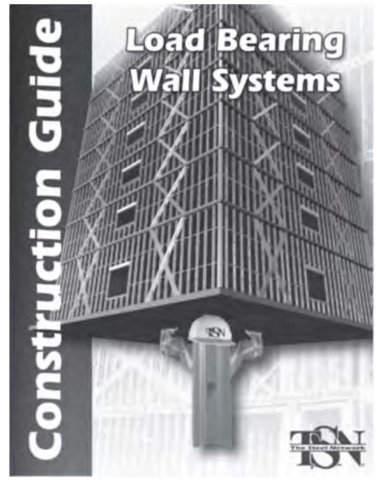


LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Guide

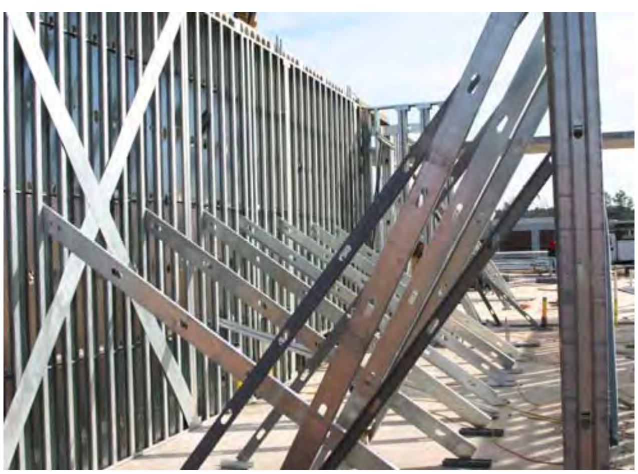
This guide educates Contractors, Architects and Engineers on construction methods of load bearing wall systems.

www.steelnetwork.com/site/Catalogs



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls

Determine Construction Loads

- Gravity Loads
  - Self-Weight
- Live Loads
  - Live Load from workers & equipment
    - 20 psf Unfactored Uniform Load (Steel Deck Institute)
    - 150 lb Concentrated Load (Steel Deck Institute)
- Wind Loads
  - 75% of design wind pressure * Surface Area (ASCE 37-02, exposed period < 6 weeks)
- Impact Loads
  - Example: Hollowcore slabs being seated on walls, horizontal force ≈ 20% of the weight of one unit

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls

ASCE 37-02, Design Loads on Structures During Construction

Two types of temporary bracing are required:

- In the plane of the wall
- Out of the plane of the wall

When temporary bracing should be removed:

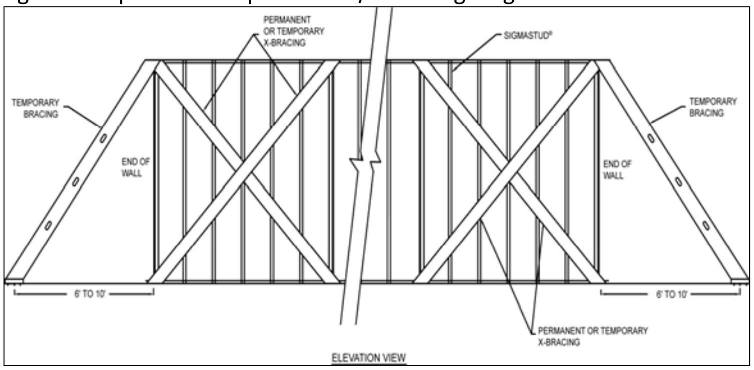
- After at least one floors above the temporarily braced wall are installed, allowing the walls to "seat"
- After all permanent shear wall bracing is installed and tightened
- After all perpendicular walls are connected

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls

In the Plane of the Wall Bracing

May use diagonal strap shear wall panels and/or adding diagonal kickers at the two ends of the wall



From TSN Construction Guide

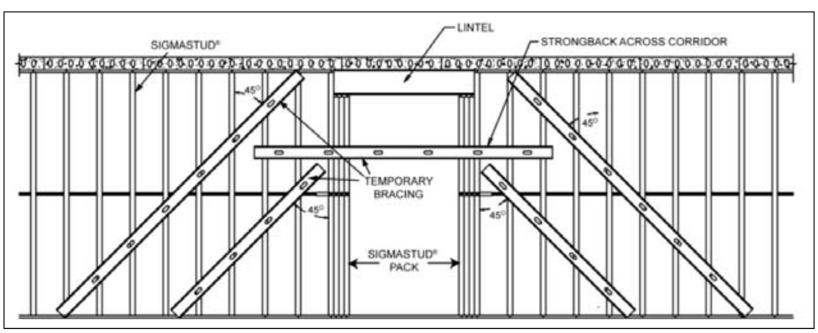
Suggested Min. Construction Bracing for Load Bearing Walls, In-Plane

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls

In the Plane of the Wall Bracing

Strong backs around and across openings



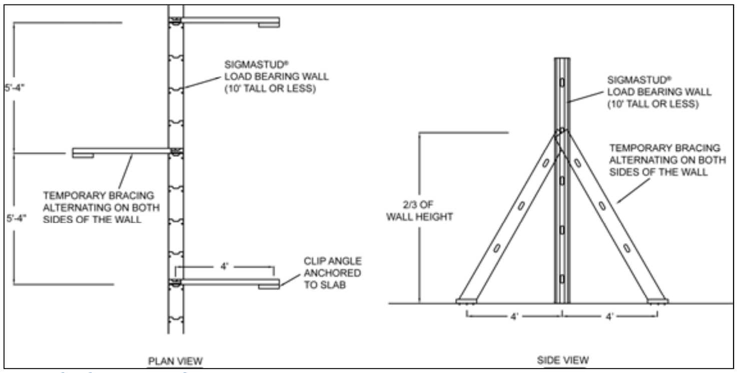
From TSN Construction Guide

Suggested Min. Construction Bracing for Load Bearing Walls, In-Plane

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls

Out of Plane of the Wall Bracing



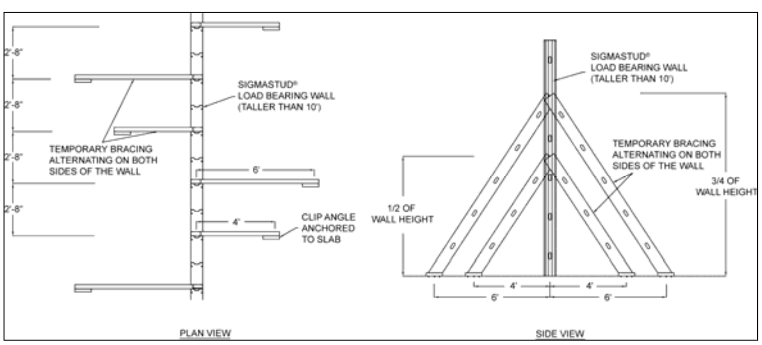
From TSN Construction Guide

Suggested Min. Construction Bracing for Load Bearing Walls less than 10 ft

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Construction Bracing - Walls

Out of Plane of the Wall Bracing



From TSN Construction Guide

Suggested Min. Construction Bracing for Load Bearing Walls Taller than 10 ft.

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Load Bearing Wall Design References

Technical Notes and Design Guides

- CFSEI Technical Notes
  - F100-09 Clip Angle Bearing Stiffener
  - J100-11 Cold-Formed Steel Floor Joists
  - L001-10 Design of Diagonal Strap Bracing
  - W200-09 Header Design
  - W400-16 Mechanical Bridging and Bridging Anchorage of Axially Loaded CFS Studs
  - W500-12 Construction Bracing for Walls

- Design Guides
  - AISI D110-16 Cold-Formed Steel Framing Design Guide
  - ASCE, Bracing Cold-Formed Steel Structures: A Design Guide

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

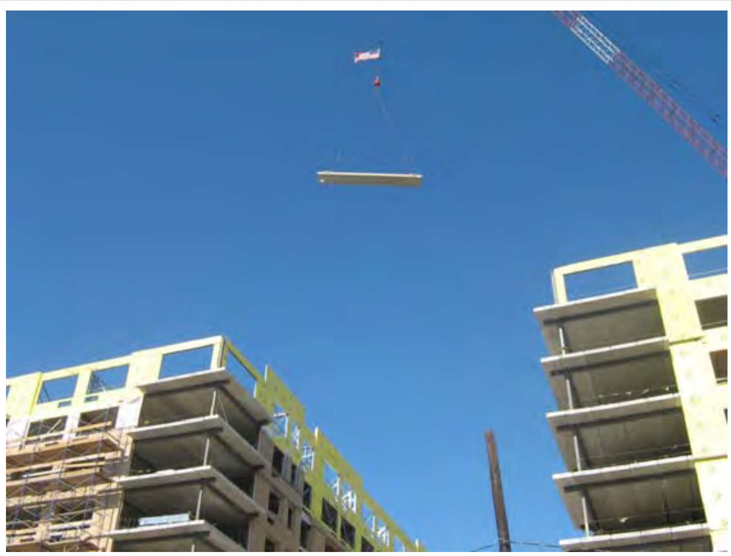
Project Examples

Port Imperial South

Weehawken, NJ

Project Facts:

- 9 Stories
- Hollow Core Plank Floor System



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

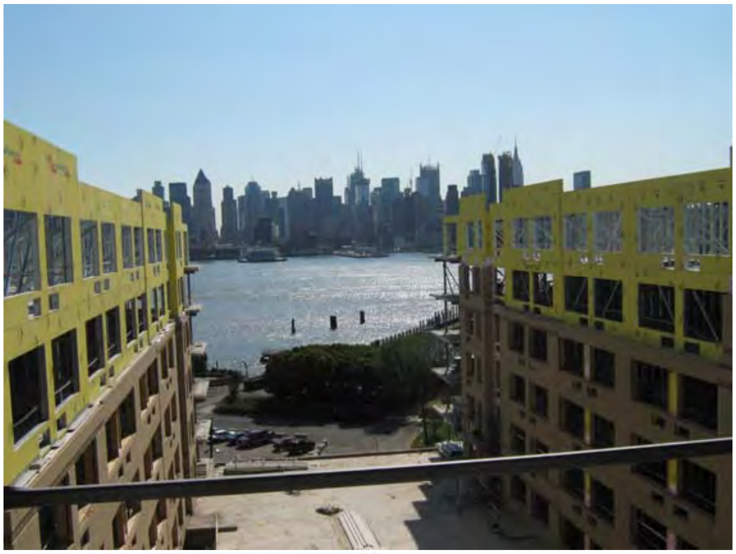
Port Imperial, Weehawken

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Port Imperial, Weehawken

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Port Imperial, Weehawken



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Port Imperial, Weehawken

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Project Examples

Springhill Suites, Webster, TX

- Composite floor slab. Completed Spring 2009
- **Owner:** Concord Hospitality
- **Architect:** Braun & Steidl, Akron, OH
- **GC:** Langston Construction, Lufkin, TX
- **Specialty Engineer:** Holland Engineering, Lindale, TX

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Springhill Suites, Webster, TX

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Springhill Suites, Webster, TX

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Springhill Suites, Webster, TX

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Wind-Bearing Curtain Walls

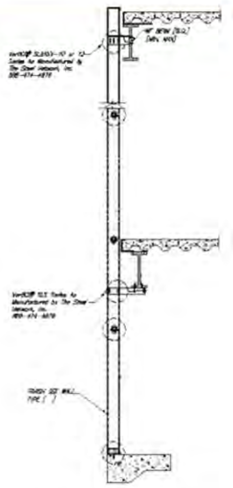
AISI S200 General Provisions:

Definition of Curtain Wall Stud

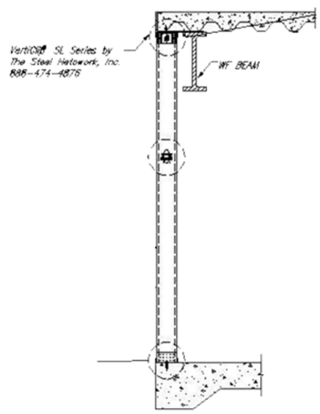
- “A wall that transfers transverse (out-of-plane) loads and is limited to a superimposed vertical load, exclusive of sheathing materials, of not more than 100 lb/ft (1.46 kN/m), or a superimposed vertical load of not more than 200 lbs (0.89 kN).”

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Types of Curtain Wall Framing



Bypass (Balloon) framing



Infill framing (Head of Wall)

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Curtain Wall Design

Serviceability (Deflection) Criteria:

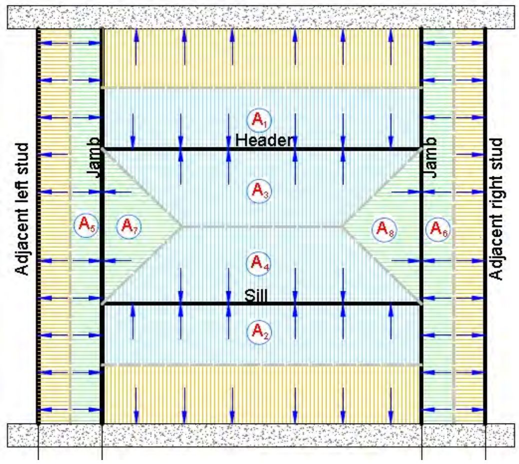
Exterior Finish	Deflection Limit
Metal Panel	L/180 – L/240
EIFS	L/240 – L/360
Stucco	L/360
Stone	L/360 – L600
Brick*	L/600 – L/720

* BIA Tech Note 28B recommends L/600 to allow maximum crack width of about 0.015 inches in the brick veneer for typical floor-to-floor dimensions

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Curtain Wall Openings

- **Components:**
  - Header
  - Sill
  - Jambs
  - Connections

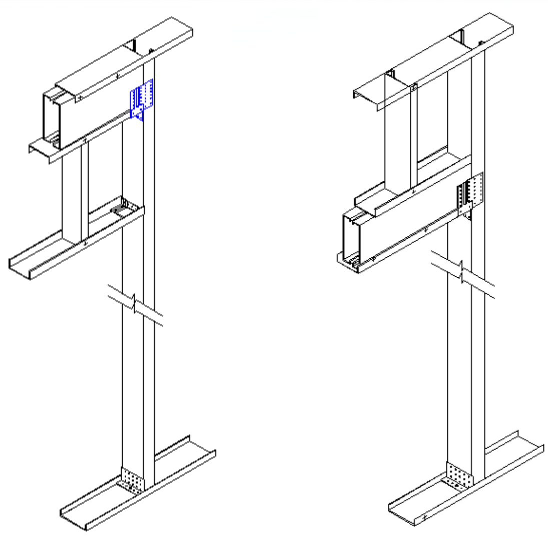


Wind Load Distribution

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Curtain Wall Openings

- **Header/Sill:**
  - Raised header
  - Dropped header



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Curtain Wall Openings

Connection of Header to Jamb

Using a Jack Stud

Using a Clip Connection

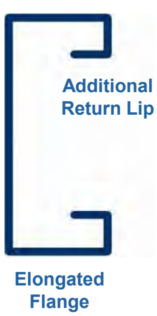
(Clip eliminates web crippling of header at bearing point)

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

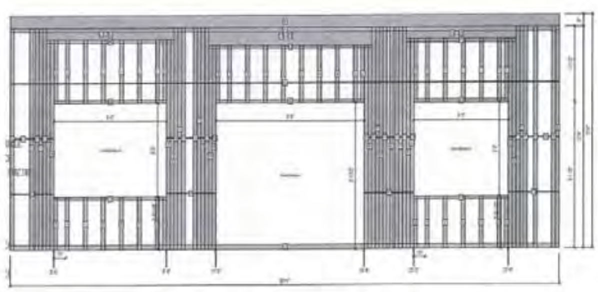
Curtain Wall Openings

Jamb:

- Built-up vs. Wide flange



Wide Flange



Built-Up Members = More Time and $$

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

©2006-17 Applied Science International, LLC

Wall Studs – Sheathing Bracing (Bending)

Bending – Section B1.3

- Flexural Strength – C3.1.1 of AISI S100
  - Initiation of Yielding (or Inelastic Reserve Capacity)
  - Neglect rotational restraint from sheathing
  - No global or distortional buckling
  - Mn = Se * Fy
    - Se = Elastic Section Modulus of the Effective Section
    - Fy = Design Yield Stress

Shear – Section B1.4

- Shear Strength – C3.2 of AISI S100
  - Same for All-Steel Design
  - Vn = Aw * Fv
    - Aw = Area of Web Element
    - Fv = Nominal Shear Stress

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Bracing – All Steel Design (Bending)

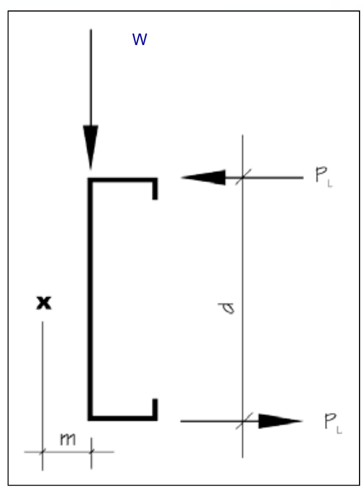
Lateral Bracing – AISI S100 Section D3.2.1

Force per Stud Flange:

- PL = 1.5 (m/d) W for uniform load (Eq. D3.2.1-3)
  - m = Shear Center Distance from Web
  - d = Stud Depth
  - W = w a
  - w = Lateral Load/ft on the Stud
  - a = Distance between Bracing Rows

Twist Moment:

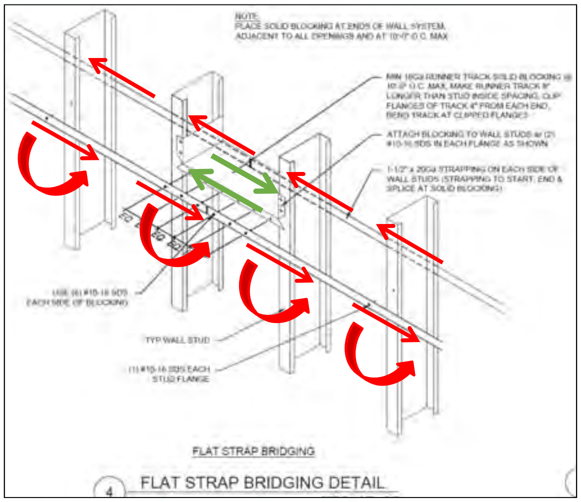
- M = PL d



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Bracing – All Steel Design (Bending)

Face-Mounted Straps (Discrete Blocking)

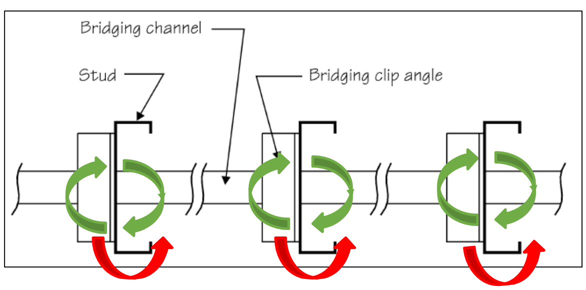


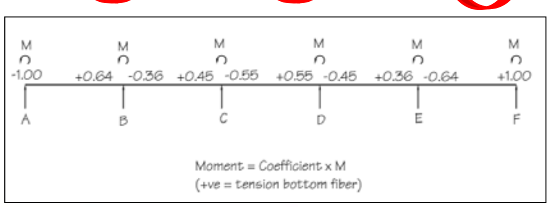
Courtesy of FDR Engineers

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Bracing – All Steel Design (Bending)

Through Punch-Out Bridging (No Discrete Blocking)





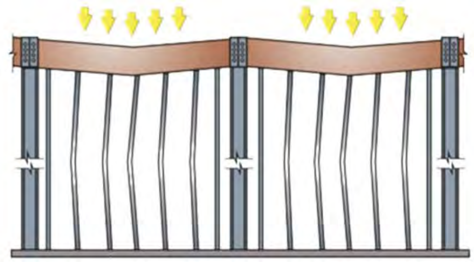
From AISI D110

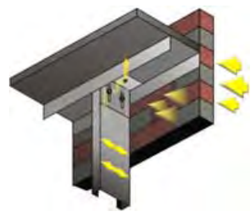
LIGHTER BETTER FASTER STRONGER TRAINING SERIES

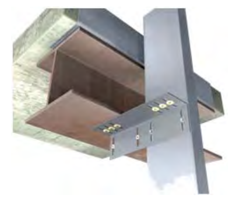
©2006-17 Applied Science International, LLC

Movement Connections

- **All Structures deflect, or move, vertically and horizontally**
- **Curtain wall studs are typically not engineered to bear the weight of the structure**
- **With 30 ft. beam span and live load deflection of L/360, you get 1" possible beam deflection in the middle**







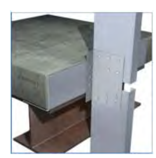
LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Vertical Deflection Solutions

MasterClip® VLB

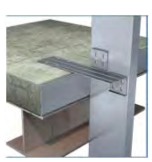
VertiTrack® VTX

VertiTrack® VT



VertiClip® Splice

VertiClip® SL



VertiClip® SLT

VertiClip® SLS

VertiClip® SLF

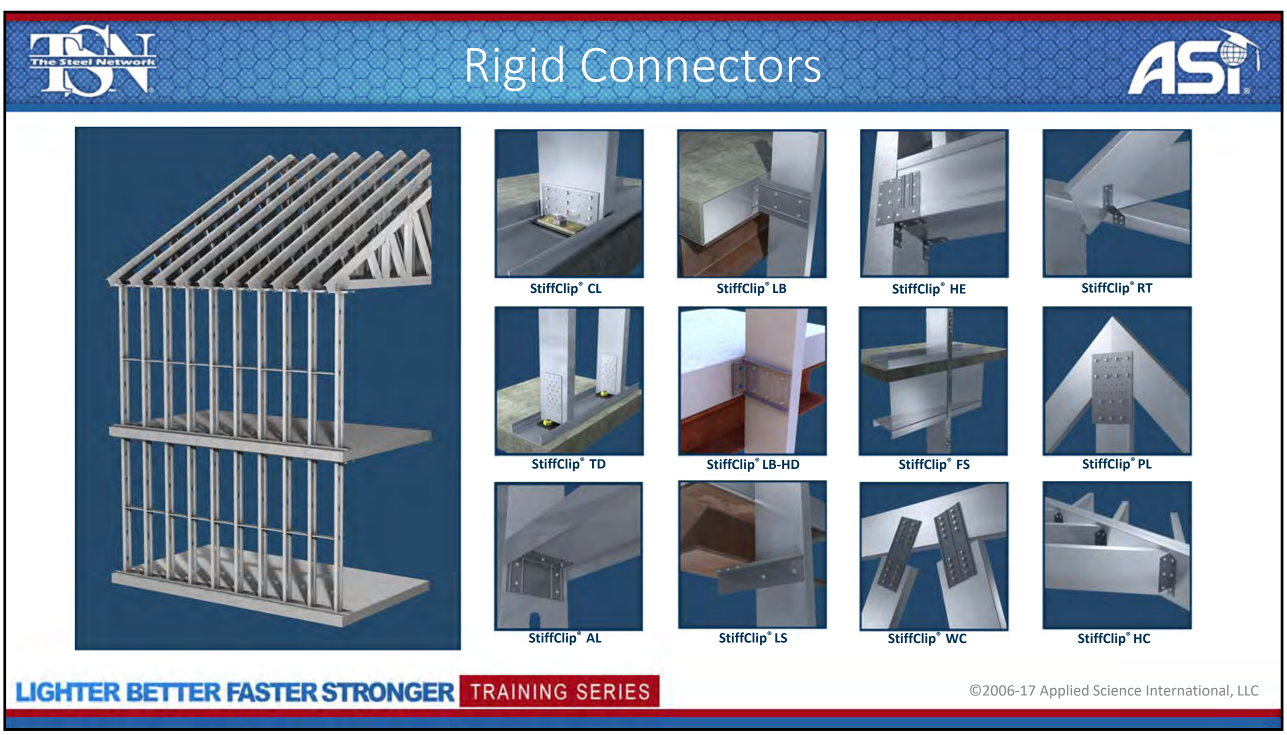
VertiClip® SLB-HD

VertiClip® SLB

***All TSN connections meet ICC AC261 requirements**
****ICC-ES Reports for VertiClip® & DriftClip® are available.**

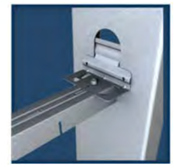
LIGHTER BETTER FASTER STRONGER TRAINING SERIES


The Steel Network
Drift Solutions
ASI
DriftClip® DSLB
DriftClip® DSL
DriftClip® DSLS
DriftClip® DSLD
DriftTrak® Headed Stud
DriftTrak® DTLB
DriftTrak® DTSLB
DritfTrak® DTSL
DriftCorner®
*All TSN connections meet ICC AC261 requirements
**ICC-ES Reports for VertiClip® & DriftClip® are available.
LIGHTER BETTER FASTER STRONGER TRAINING SERIES
©2006-17 Applied Science International, LLC


The Steel Network
Rigid Connectors
ASI
StiffClip® CL
StiffClip® LB
StiffClip® HE
StiffClip® RT
StiffClip® TD
StiffClip® LB-HD
StiffClip® FS
StiffClip® PL
StiffClip® AL
StiffClip® LS
StiffClip® WC
StiffClip® HC
LIGHTER BETTER FASTER STRONGER TRAINING SERIES
©2006-17 Applied Science International, LLC

Bridging Connections

BuckleBridge®



BridgeClip®

BC600/800

BridgeBar®

NotchTrak® HD

NotchTrak® NT

Curtain Wall Design References

Technical Notes and Design Guides

- CFSEI Technical Notes
  - W101-09: Common Design Issues for Deflection Track
  - W102-12: Introduction to Curtain Wall Design Using Cold-Formed Steel
  - W103-11: Design of By-Pass Slip Connectors in Cold-Formed Steel Construction
- Design Guides
  - AISI D110-16 Cold-Formed Steel Framing Design Guide
  - ASCE, Bracing Cold-Formed Steel Structures: A Design Guide

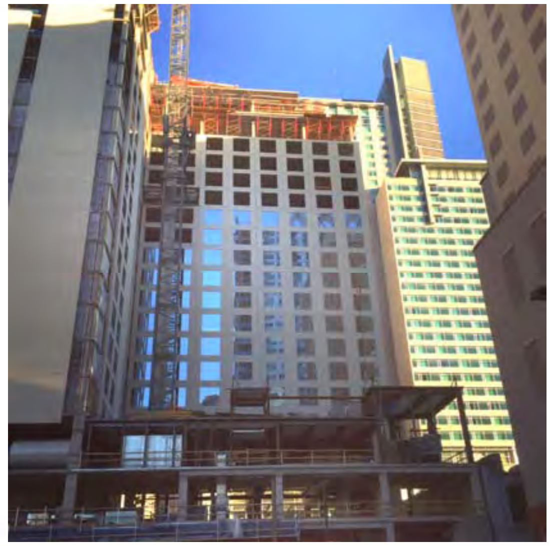
TECHNICAL NOTE
On Cold-Formed Steel Construction

INTRODUCTION TO CURTAIN WALL DESIGN USING COLD-FORMED STEEL

Project Examples

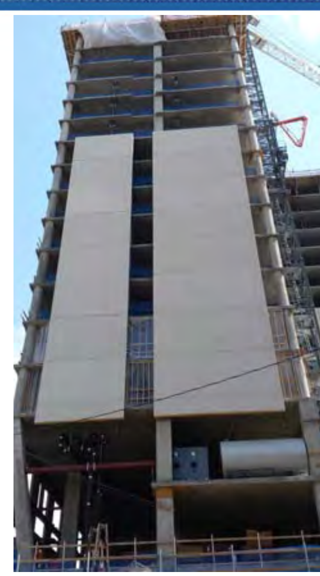
La Meridien, AC – Denver, CO

- 20 story Exterior LSF. Completed October 2016
- Owner: Hotden, LLC, IN
- Architect: HKS, Dallas, TX
- Exterior LSF Panels: South Valley Drywall, CO



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

La Meridien, AC – Denver, CO



LIGHTER BETTER FASTER STRONGER TRAINING SERIES

La Meridien, AC – Denver, CO

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Design Software

https://www.steelsmartsystem.com

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Thank You!

Nabil A. Rahman, Ph.D., P.E.
Director of Engineering and R&D
The Steel Network, Inc.
2012A T.W. Alexander Dr., Durham, NC 27709
919-354-3716
nabil@steelnetwork.com

LIGHTER BETTER FASTER STRONGER TRAINING SERIES

Next Steps - Need Help Designing CFS?

Download the #1 CFS Design Software on the market!

- **Have an ASI Portal Account?**
  Login Here:
  https://portal.appliedscienceint.com/Account/Login

- **Don't have an ASI Portal Account?**
  Register Here:
  https://portal.appliedscienceint.com/Account/Register

Next Steps – Design Assistance

Want to see if we can save you Labor on your next project?

Utilize our free Design Assist Service to see how TSN's products might save you time and money. This service is one step below shop drawings and will show you how you can optimize connectors and framing.

Benefits of Design Assist:

- Reduce Cost
- Win More Jobs
- Save Labor Hours
- Accelerate Construction Schedules

Find your Sales Rep and Ask them for Design Assistance Today:
https://steelnetwork.com/site/MeetSales