Prescriptive Method for Connecting

Cold-Formed Steel Framing to Insulating Concrete Form Walls

in Residential Construction

Prepared for:

U.S. Department of Housing and Urban Development
Office of Policy Development and Research
Washington, DC

The Steel Framing Alliance
Washington, DC

The Portland Cement Association
Skokie, IL

The Insulating Concrete Form Association
Glenview, IL

Prepared by:

Building Works, Inc.
Cambridge, MA

Contract H-21311CA

February 2003

PATH (Partnership for Advancing Technology in Housing) is a new private/public effort to develop, demonstrate, and gain widespread market acceptance for the "Next Generation" of American housing. Through the use of new or innovative technologies, the goal of PATH is to improve the quality, durability, environmental efficiency, and affordability of tomorrow's homes.

PATH is managed and supported by the U.S. Department of Housing and Urban Development (HUD). In addition, all federal agencies that engage in housing research and technology development are PATH Partners, including the Departments of Energy, Commerce, and Agriculture as well as the Environmental Protection Agency (EPA) and the Federal Emergency Management Agency (FEMA). State and local governments and other participants from the public sector are also partners in PATH. Product manufacturers, home builders, insurance companies, and lenders represent private industry in the PATH Partnership.

To learn more about PATH, please contact

451 7th Street, SW
Suite B 133
Washington, DC 20410
202-708-5873 (fax)
202-708-4277 (phone)
e-mail: pathnet@pathnet.org
website: www.pathnet.org

Visit PD&R's website
www.huduser.org
to find this report and others sponsored by
HUD's Office of Policy Development and Research (PD&R).

Other services of HUD USER, PD&R's Research Information Service, include listservs; special interest, bimonthly publications (best practices, significant studies from other sources); access to public use databases; and a hotline 1-800-245-2691 for help accessing the information you need.

DISCLAIMER

Neither the U.S. Department of Housing and Urban Development of the U.S. Government, nor the Portland Cement Association, nor the Steel Framing Alliance, nor the Insulating Concrete Form Association, nor Building Works, Inc., nor its employees or representatives makes any warranty, guarantee, or representation, expressed or implied, with respect to the accuracy or completeness of information contained in this document or its fitness for any particular purpose, or assumes any liability for damages or injury resulting from the applications of such information. Users are directed to perform all work in accordance with applicable building code requirements.

NOTICE

The contents of this report are the views of the contractor and do not necessarily reflect the views or policies of the U.S. Department of Housing and Urban Development or the U.S. government. The U.S. government does not endorse products or manufacturers. Trade or manufacturer names appear herein solely because they are considered essential to the object of this report.

Preface

In recent years construction of single-family homes with exterior walls of insulating concrete forms has grown rapidly. The use of cold-formed steel for the construction of residential interior walls, floors, and roofs has likewise grown rapidly. The reasons given for use of both materials include:

- Durability
- Strength
- Material consistency
- Price stability of material
- Ecological concerns

Yet builders who have combined insulating concrete forms and cold-formed steel framing in homes complain of a lack of information on making the connections. Many say that they believe they are employing overly involved and expensive methods. However, they are unwilling to employ simpler methods for fear that the connections might be inadequate.

This publication is intended to alleviate these problems by providing construction details and schedules for the connection of cold-formed steel frame walls, floor decks, and roofs to insulating concrete form exterior walls, based on engineering analysis and common building requirements. It is also intended to provide code officials and inspectors with the guidance necessary to perform their duties in home construction when these materials are used. Note that this publication is intended for use only by qualified industry professionals who can evaluate the applicability of its recommended details in specific projects and circumstances.

By facilitating the construction of houses from insulating concrete forms and cold-formed steel, HUD expands housing affordability and quality through competition from new methods and materials.

Acknowledgments

This publication was produced under contract to the U.S. Department of Housing and Urban Development, the Steel Framing Alliance, the Insulating Concrete Form Association, and the Portland Cement Association. It was researched and developed at Building Works, Inc. Ivan S. Panushev, supervised all engineering and technical content, and Pieter A. VanderWerf, Ph.D., provided guidance and general project management.

This book is the third publication in a prescriptive method series produced by the U.S. Department of Housing and Urban Development on insulating concrete forms and cold-formed steel framing. We would like to thank all individuals involved in preparing those publications on which Chapters 2 and 3 are largely based.

Special appreciation for review and supervision is extended to the members of the steering committee:

Karen Bexten, P.E., Tadros Associates, LLC.
Kevin Bielat, American Iron and Steel Institute
William Freeborne, P.E., U.S. Department of Housing and Urban Development
Jonathan Humble, A.I.A., American Iron and Steel Institute
William Oliver, WMWN, Inc.
Daniel Peterson, PK Construction
David Shepherd, A.I.A., Portland Cement Association
Andrea Vrankar, P.E., R.A, U.S. Department of Housing and Urban Development
Timothy Waite, P.E., Steel Framing Alliance

The authors gratefully acknowledge the assistance of the following individuals and organizations:

Bill Kraft, Steel Framing Alliance

Nader Elhajj, P.E., NAHB Research Center, Inc.

Vern Jones, Intertek Testing Services

Roger Laboube, Ph.D., University of Missouri - Rolla

Jay Larson, P.E., Bethlehem Steel Co.

Paul Lynch, Fairfax County, Virginia

Teoman Pekoz, Ph.D., Cornell University

Larry Williams, Light-Gauge Steel Engineers Association

American Polysteel Forms, Inc.

Amvic Building Systems, Inc.

Architectural/Residential Technologies, Inc.

ARXX Building Products, Inc.

Bailey Metal Products, Ltd.

Construction Technologies Laboratories, Inc.

Dietrich Metal Framing, Inc.

Insul-Deck, Inc.

Intertek Testing Services

Lite-Form Technologies, Inc.

NUCONSTEEL, Co.

Quad-Lock, Inc

Reward Wall Systems, Inc.

Simpson Strong-Tie Co., Inc.

Table of Contents

Preface v
Acknowledgements vii
Executive Summary xv

Chapter 1: Introduction 1

Chapter 2: General 3

Purpose 3
Approach 3
Scope 3
Definitions 7

Chapter 3: Materials, Shapes, and Standard Sizes 15

Insulating Concrete Forms 15
Flat ICF Wall Systems 16
Waffle-Grid ICF Wall Systems 16
Screen-Grid ICF Wall Systems 16
Form Materials 17
Concrete Materials 17
Concrete Mix 17
Compressive Strength 18
Reinforcing Steel 18
Cold-Formed Steel 18
Material 18
Corrosion Protection 18
Member Designation 19
Physical Dimensions 20
Base Metal Thickness 22
Bend Radius 22
Yield Strength 22
Product Identification 23
Performance of Steel in Homes 23
Galvanized Steel in Contact With Building Materials 23
Bearing Stiffeners 24
Clip Angles 24
Fasteners 24
Drive Pins and Nails 31
Bolts 31

Chapter 4: ICF-to-Steel Floor Connection Methods 33

Introduction 33
Applicability Limits 33
Floor Connection Requirements 34
Anchor Bolt 34
Right Angle Steel Plate 36
Connection at End Floor Joist 37
Steel-and-Concrete Floors 41
Concrete - Topped Steel Deck 41
Foam/CFS Concrete Form Deck 42
CFS Joist/Concrete Composite 43

Chapter 5: ICF-to-Steel Non-Structural Wall Connection Methods .. 45

Introduction 45
Applicability Limits 46
Basic Interior Wall Requirements 46
Construction Details 46

Chapter 6: ICF-to-Steel Exterior Wall Connection Methods 49

Introduction 49
Applicability Limits 49
Exterior Wall Connection Requirements 50
Direct Track to ICF Wall Connection 50
Track to ICF Wall Connection with Wood Sill and Steel Plate 51
Track to ICF Wall Connection with Wood Sill and Uplift Strap 52

Chapter 7: ICF-to-Steel Roof Connection Methods 57

Introduction 57
Applicability Limits 57
Basic Roof Connection Requirements 58
Top Plate Connected to ICF Wall With Concrete Anchor Steel Straps 58
Embedded Steel Strap 60
Right-Angle Steel Strap With Epoxy Anchor Bolt 62

Chapter 8: References 67

Appendix, Metric Conversion 71

List of Tables

TABLE 2.1 APPLICABILITY LIMITS 5

TABLE 2.2 EQUIVALENT BASIC WIND SPEEDS 14

TABLE 3.1 DIMENSIONAL REQUIREMENTS FOR CORES AND WEBS IN WAFFLE- AND SCREEN- GRID ICF WALLS 16

TABLE 3.2 COLD-FORMED STEEL MEMBER SIZES 20

TABLE 3.3 MINIMUM THICKNESS OF COLD-FORMED STEEL MEMBERS 22

TABLE 3.4 MINIMUM COATING REQUIREMENTS 23

TABLE 3.5 SCREW BODY DIAMETER 26

TABLE 3.6 SCREW SUBSTITUTION FACTOR 30

TABLE 4.1 LATERAL VELOCITY PRESSURE FOR DETERMINATION OF ICF-TO-FLOOR CONNECTION REQUIREMENTS 38

TABLE 4.2 MAXIMUM CONNECTOR SPACING AT STEEL LEDGER TRACK TO ICF WALL CONNECTION 39

TABLE 4.3 ADDITIONAL CAPACITY REQUIRED (PLF) FOR LEDGER TRACK TO ICF WALL CONNECTION IN DESIGN CATEGORIES C, D1 AND D2 40

TABLE 4.4 MINIMUM NUMBER OF ANCHOR BOLTS REQUIRED ALONG END FLOOR JOIST TO ICF SIDE WALL CONNECTION 40

TABLE 6.1 LATERAL WIND VELOCITY PRESSURE FOR DETERMINATION OF ICF-TO-EXTERIOR STEEL WALL CONNECTION REQUIREMENTS 53

TABLE 6.2 BASIC ICF-TO-EXTERIOR STEEL WALL CONNECTION REQUIREMENTS . 53

TABLE 6.3 ICF-TO-EXTERIOR STEEL WALL UPLIFT CONNECTION CAPACITY AT EACH FRAMING MEMBER 54

TABLE 6.4 TOTAL NUMBER OF NO. 8 SCREWS IN FLANGES OF WALL STUD TO STEEL STRAP CONNECTION 55

TABLE 7.1 LATERAL WIND VELOCITY PRESSURE FOR DETERMINATION OF ICF-TO-STEEL ROOF CONNECTION REQUIREMENTS 63

TABLE 7.2 CONCRETE ANCHOR STEEL STRAP SPACING TO CONNECT SILL PLATE TO ICF WALL 64

TABLE 7.3 ROOF FRAME TO SILL PLATE REQUIRED UPLIFT CONNECTION CAPACITY 64

TABLE 7.4 FASTENER SCHEDULE FOR STEEL STRAPS AT ICF WALL PARALLEL TO RIDGE 65

TABLE 7.5 STEEL STRAP SPACING TO CONNECT END ROOF TRUSS OR JOIST TO ICF WALL PERPENDICULAR TO RIDGE 66

List of Figures

Figure 2.1. Insulating Concrete Form (ICF) Systems 6
Figure 3.1. Flat ICF Wall Systems 15
Figure 3.2. Waffle-Grid ICF Wall Systems 17
Figure 3.3. Screen-Grid ICF Wall Systems 17
Figure 3.4. Track Section Dimensions 21
Figure 3.5. C-Shape Section Dimensions 21
Figure 3.6. Screw Point Type 25
Figure 3.7. Screw Length Measurements 26
Figure 3.8. Screw Grip Range 27
Figure 3.9. Screw Head Types 28
Figure 3.10. Screw Drive Types 29
Figure 3.11 Floor Sheathing-to-Steel Connection 29
Figure 3.12. Steel-to-Steel Screw Connection 30
Figure 4.1. Anchor Bolt to Ledger Track Connection 35
Figure 4.2. Right Angle Plate to Ledger Track Connection 36
Figure 4.3. Connection at End Floor Joist 37
Figure 4.4-A. Concrete-topped Steel Deck 42
Figure 4.4-B. Foam/CFS Concrete Form Deck 43
Figure 4.4-C. CFS Joist/Concrete Composite 44
Figure 5.1. Typical ICF-to-Light Gauge Steel Wall Connection Details 47
Figure 6.1. Direct Track to ICF Wall Connection 50
Figure 6.2. Track to ICF Wall Connection with Wood Sill and Steel Plate 51
Figure 6.3. Track to ICF Wall Connection with Wood Sill and Uplift Strap 52
Figure 7.1. Steel Concrete Anchor Strap and Sill Plate Connection Method at Wall Parallel to Ridge 58
Figure 7.2. Steel Concrete Anchor Strap and Sill Plate Connection Method at Wall Perpendicular to Ridge 59
Figure 7.3. Steel Strap Connection at Wall Parallel to Ridge 60

Figure 7.4. Steel Strap Connection Method at End Roof Joist to Wall Perpendicular to Ridge 61

Figure 7.5. Steel Strap Connection With Epoxy Anchor at Wall Parallel to Ridge 62

Figure 7.6. Steel Strap With Epoxy Anchor Connection Method at End Roof Joist to Wall Perpendicular to Ridge 63

Executive Summary

The *Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls in Residential Construction* was developed as a guideline for the connection of cold-formed steel (CFS) frame assemblies and structures to insulating concrete form (ICF) exterior walls in the construction of single-family homes. These guidelines are only intended to apply subject to the limitation presented in Chapter 2. They are intended for use only by qualified industry professionals who can evaluate their applicability in specific projects and circumstances.

The common connections between cold-formed steel framing and insulating concrete form walls are:

- CFS interior walls to ICF exterior walls;
- CFS floor decks to ICF exterior walls;
- CFS roof structures to ICF exterior walls; and
- Upper-story CFS exterior walls to lower-story ICF exterior walls.

For each connection there are alternative connection methods that are believed to be economical and reliable. The chapters that follow contain recommended specifications for such connections.

Non-loadbearing interior CFS walls in many cases require no connection to the ICF exterior wall. Where the interior wall will be subject to high lateral forces or vibrations, a simple fastener to the ICF wall or to some form of plate fastened to the ties is recommended.

CFS floor decks include ledger tracks to which the joists are fastened. These ledger tracks may be fastened to the ICF exterior wall by means of anchor bolts or right angle ledger connectors. Within specified limits, the joists may be fastened to the tracks directly by means of self-tapping sheet metal screws.

The end joists of CFS floor decks are to be attached to the side walls of the building. This may be accomplished by means of anchor bolts.

In addition to floor decks consisting of CFS joists and plywood or OSB sheathing, there are several floor systems that create floor decks entirely of steel and concrete components. This document provides general descriptive information regarding several such systems.

CFS roof members (trusses or joists and rafters) may be connected to the ICF walls directly by means of embedded steel straps. Alternatively, they may be connected to a top plate by means of steel connection plates, and the plate connected to the ICF walls by means of embedded steel straps. As a third alternative, roofing members may be connected to the ICF wall directly be means of anchor bolts adhered into special holes drilled in the concrete after the concrete has cured.

The end roof members are to be connected to the ICF side walls at various intermediate

points. This may be accomplished by any of the same three methods that the other roof connections are made.

Upper-story CFS exterior walls may be connected to lower-story ICF exterior walls by means of anchor bolts through the bottom plate of the CFS wall.

Chapter 1

Introduction

The materials set forth herein are for general information only. They are not a substitute for competent professional assistance. Application of this information to a specific project or setting should be reviewed by a qualified individual. The authors believe that the information contained in this publication substantially represents industry practice and related scientific and technical information, but the information is not intended to represent an official position of any organization or to restrict or exclude any other construction or design technique. Anyone making use of the information set forth herein does so at his or her own risk and assumes any resulting liability.

Note that references made to other publications are in brackets [ ] throughout the body of this document. All references can be found in Chapter 8.

Chapter 1

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Chapter 2

General

Purpose

The purpose of this document is to provide a prescriptive method for the connection of cold-formed steel framing members and assemblies to exterior walls built of insulating concrete forms. These provisions include definitions, connection details, fastener schedules, and other related information appropriate for use by homebuilders, design professionals, and building code officials.

Approach

These requirements are based primarily on the American Iron and Steel Institute's (AISI) Specification for the *Design of Cold-Formed Steel Structural Members* [1] for steel member strength, on the American Concrete Institutes's (ACI) *Building Code Requirements for Structural Concrete* [2], on the *Structural Design of Insulating Concrete Form Walls in Residential Construction* [3] for concrete design and specification, and on the *Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings* [29] for steel framing requirements. The provisions for building loads are based on the American Society of Civil Engineers' (ASCE) *Minimum Design Loads for Buildings and Other Structures* [4], the *International Building Code* [5], and the *International Residential Code* [6].

These provisions are intended to represent sound engineering and construction practice, taking into account the need for practical and affordable construction techniques for residential buildings. This document is not intended to restrict the use of sound judgment or exact engineering analysis of specific applications.

Scope

The provisions of this *Prescriptive Method* apply to the construction of detached one- and two- family dwellings, townhouses, and other attached single-family

dwellings in compliance with the general limitations of Table 2.1. The limitations are intended to define the appropriate use of this document for most one- and two-family dwellings. Using insulating concrete forms and cold-formed steel systems with other construction materials in a single structure shall be in accordance with the applicable building code requirements for that material, the general limitations of Table 2.1, and relevant provisions of this document. An engineered design shall be required for applications that do not meet the limitations of Table 2.1.

The provisions of the *Prescriptive Method* shall not apply to irregular structures or portions of structures in Seismic Design Categories C, D_1, and D_2. Only such irregular portions of structures shall be designed in accordance with accepted engineering practice to the extent such irregular features affect the performance of the structure. A portion of the building shall be considered to be irregular when one or more of the following conditions occur:

- Exterior shear wall lines are not in one plane vertically from the foundation to the uppermost story in which they are required (i.e., cantilevers).
- A section of floor or roof is not laterally supported by shear walls on all edges.
- An opening in the floor or roof exceeds the lesser of 12 ft (3.7 m) or 50 percent of the least floor dimension.
- Portions of the floor are vertically offset.
- Shear walls (i.e. exterior ICF walls) do not occur in two perpendicular directions.
- Shear walls are constructed of dissimilar systems on any one story level.

TABLE 2.1
APPLICABILITY LIMITS

ATTRIBUTE	MAXIMUM LIMITATIONS
General	
Building Dimensions	60 feet with center bearing wall or beam 32 feet without center bearing wall or beam
Number of Stories	2 stories above grade with a basement
Design Wind Speed	130 mph (209 km/h) 3-second gust
Ground Snow Load	70 psf (3.4 kPa)
Seismic Design Category	A, B, C, D_1 and D_2 (Seismic Zones (0, 1, 2, 3, and 4)
Floors	
Floor Dead Load	10 psf (0.72 kPa)
First-Floor Live Load	40 psf (1.9 kPa)
Second-Floor Live Load (sleeping rooms)	30 psf (1.4 kPa)
Floor Clear Span (unsupported)	32 feet (9.8 m)
Walls - Concrete	
Unit Weight of Concrete	150 pcf (23.6 kN/m^3)
Wall Height (unsupported)	10 feet (3 m)
Walls - Cold-Formed Steel	
Wall Dead Load	10 psf (0.48 kN/m^2)
Load Bearing Wall Height	10 feet (3 m)
Roofs	
Roof and Ceiling Dead Load	15 psf (0.72 kPa)
Roof Live Load (ground snow load)	70 psf (3.4 kPa)
Roof Slope	3:12 to 12:12
Attic Live Load	20 psf (0.96 kPa)
Roof Clear Span (unsupported)	32 feet (9.8 m)

For SI: 1 foot = 0.3048 m; 1psf = 47.8804 Pa; 1 pcf = 157.0877 N/m^3 = 16.0179 kg/m^3; 1 mph = 1.6093 km/hr

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

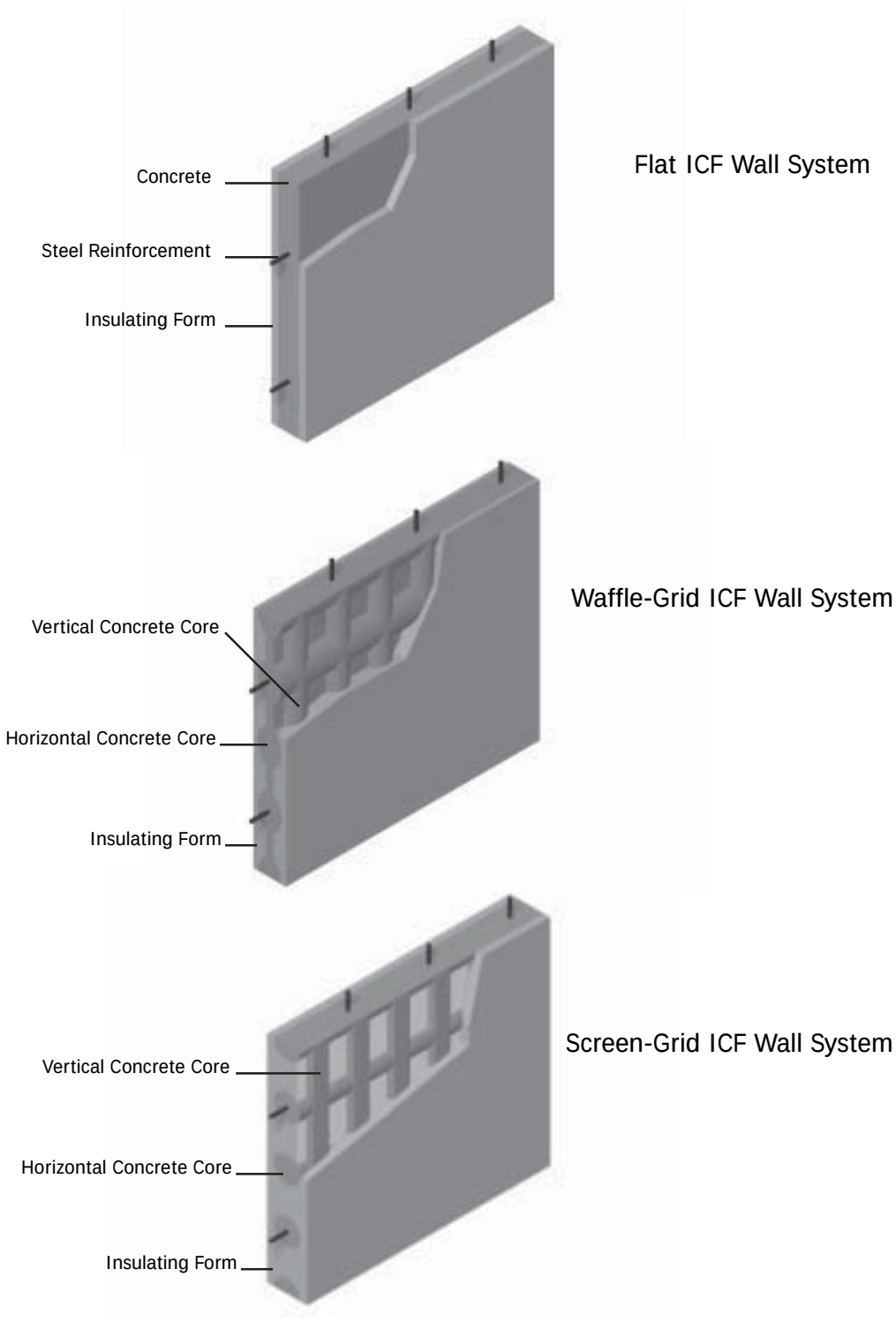


Figure 2.1. Insulating Concrete Form (ICF) Systems

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Definitions

The following are definitions of key terms as they are used in this document. Figure 2.1 illustrates certain terms as referenced by these definitions.

Accepted Engineering Practice: An engineering approach that conforms with accepted principles, tests, technical standards, and sound judgment.

Anchor Bolt: A bolt, headed or threaded, used to connect a structural member of different material to a concrete member.

Approved: Reference to approval by the building code authority having jurisdiction. A rational design by a competent design professional shall constitute grounds for approval.

Attic: The enclosed space between the ceiling joists of the top-most floor and the roof rafters of a building not intended for occupancy but sometimes used for storage.

Authority Having Jurisdiction: The organization, political subdivision, office, or individual charged with the responsibility of administering and enforcing the provisions of applicable building codes.

Axial Load: The longitudinal force acting on a member. Examples are the gravity loads carried by columns or studs.

Backfill: The soil that is placed adjacent to completed portions of a below-grade structure (i.e., basement) with suitable compaction and allowance for settlement.

Basement: That portion of a building, which is partly, or completely below grade and which may be used as habitable space.

Bearing Stiffener: Additional material that is attached to the web to strengthen the member against web crippling. Also called a web stiffener.

Bond Beam: A continuous horizontal beam of concrete with steel reinforcement located in the exterior walls of a structure to tie the structure together and distribute loads.

Buckling: A kink, wrinkle, bulge, or otherwise loss of the original shape of a member due to compressive, bending, bearing, or shear loads.

Building: Any one- or two-family dwelling or portion thereof that is used for human

habitation.

Building Length: The dimension of a building that is perpendicular to roof rafters, roof trusses, or floor joists (L).

Building Width: The dimension of a building that is parallel to roof rafters, roof trusses, or floor joists (W).

Ceiling Joist: A horizontal structural framing member that supports ceiling components and which may be subject to attic loads.

C-Shape: A cold-formed steel shape used for structural and non-structural framing members consisting of a web, two (2) flanges and two (2) lips (edge stiffeners).

Clip Angle: An L-shaped short piece of metal (normally with a 90-degree bend), typically used for connections.

Cold-Formed Sheet Steel: A process where light-gauge steel members are manufactured by (1) press-braking blanks sheared from sheets or cut length of coils or plates, or by (2) continuous roll forming of cold- or hot-rolled coils of sheet steel; both forming operations are performed at ambient room temperature, that is, without any addition of heat such as would be required for hot forming.

Compressive Strength: The maximum ability of concrete to resist a compressive load, usually measured in pounds per square inch (psi) or Pascals (Pa). The compressive strength is based on compression tests of concrete cylinders that are moist-cured for 28 days in accordance with ASTM C 31 [7] and ASTM C 39 [8].

Concrete Web: A concrete wall segment as per Figure 2.1, a minimum of 2 inches (51 mm) thick, connecting the vertical and horizontal concrete members (cores) of a waffle-grid ICF wall or lintel member. Webs may contain form ties but are not reinforced (i.e., vertical or horizontal reinforcement or stirrups).

Crawlspace: A type of building foundation that uses a perimeter foundation wall to create an under floor space which is not habitable.

Dead Load: Forces resulting from the weight of walls, partitions, framing, floors, ceilings, roofs, and all other permanent construction entering into, and becoming part of, a building.

Deflection: Elastic movement of a loaded structural member or assembly (i.e., beam or wall).

Design Professional: An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the state in which the project is to be constructed.

Design (or Basic) Wind Speed: Related to winds that are expected to be exceeded once every 50 years at a given site (i.e., 50-year return period). Wind speeds in this document are given in units of miles per hour (mph) by 3-second gust measurements in accordance with ASCE 7 [4].

Dwelling: Any building that contains one or two dwelling units for living purposes.

Edge Stiffener: The part of a C-shape framing member that extends from the flange as a stiffening element that extends perpendicular to the flange.

Endwall: The exterior wall of a building which is perpendicular to the roof ridge and parallel to floor framing, roof rafters, or trusses. It is normally the shorter dimension of a rectangular building's footprint.

Exposure Categories: Reflects the effect of the ground surface roughness on wind loads in accordance with ASCE 7 [4]. Exposure Category B includes urban and suburban areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Exposure Category C includes open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m) and shorelines in hurricane prone regions. Exposure D includes open exposure to large bodies of water in non-hurricane-prone regions.

Flange: The portion of the C-shape framing member or track that is perpendicular to the web.

Flat Wall: A solid concrete wall of uniform thickness produced by ICFs or other forming systems.

Floor Joist: A horizontal structural framing member that supports floor loads and superimposed vertical loads.

Form Tie: The element of an ICF system that holds both sides of the form together. Form ties can be steel, solid plastic, foam plastic, a composite of cement and wood chips, a composite of cement and foam plastic, or other suitable material capable of resisting the loads created by wet concrete. Form ties remain permanently embedded in the concrete wall.

Foundation: The structural elements through which the load of a structure is transmitted to the earth.

Foundation Wall: The structural element of a foundation that transmits the load of a structure to the earth; includes basement, stem, and crawlspace walls.

Grade: The finished ground level adjoining the building at all exterior walls.

Ground Snow Load: Measured load on the ground due to snow accumulation developed from a statistical analysis of weather records expected to be exceeded once every 50 years at a given site.

Horizontal Reinforcement: Steel reinforcement placed horizontally in concrete walls to provide resistance to temperature and shrinkage cracking. In certain circumstances, horizontal reinforcement is required for additional strength around openings and in high loading conditions such as experienced in hurricanes and earthquakes.

In-Line Framing: A framing method where all vertical and horizontal load carrying members are aligned.

Insulating Concrete Forms (ICFs): A concrete forming system using stay-in-place forms of foam plastic insulation, a composite of cement and foam insulation, a composite of cement and wood chips, or other insulating material for constructing cast-in-place concrete walls. Some systems are designed to have one or both faces of the form removed after construction.

J Bolt: A threaded anchor bolt typically embedded in concrete with threads on one end and a crook in the shank at the other; used to connect a structural member of different material to a concrete member.

Lateral Load: A horizontal force, created by wind or earthquake, acting on a structure or its components.

Lateral Support: A horizontal member providing stability to a column or wall across its smallest dimension.

Ledger: A horizontal structural member fastened to a wall to serve as a connection point for other structural members, typically floor joists.

Lip: See edge stiffener.

Live Load: Any gravity load that is not permanently applied to a structure; typically transient and sustained gravity forces resulting from the weight of people and furnishings, respectively.

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Material Thickness (Steel): The base metal thickness excluding any protective coatings. Thickness is now commonly expressed in mils (1/1000 of an inch).

Metallic Coated Steel: Steel that has a metallic coating for protection against corrosion. The level of protection provided is measured by the weight of the metallic coating applied to the surface area of the steel. Typical metallic coatings are galvanizing, galvalume, or galfan, which are zinc-based.

Mil: A unit of measurement equal to 1/1000 of an inch (e.g., 33 mil = 0.033 inch).

Multiple Span: The span made by a continuous member having intermediate supports.

Non-Structural Walls: Refer to walls.

Post-and-Beam Wall: A perforated concrete wall with widely spaced (greater than that required for screen-grid walls) vertical and horizontal concrete members (cores) with voids in the concrete between the cores created by the ICF form (i.e., flat, waffle-, or screen-grid as per Figure 2.1).

Ridge: The horizontal line formed by the joining of the top edges of two sloping roof surfaces.

Roof Snow Load: Uniform live load on the roof due to snow accumulation; roughly equivalent to 70 to 80 percent of the ground snow load in accordance with ASCE 7 [4].

Screen-Grid Wall: A perforated concrete wall with closely spaced vertical and horizontal concrete members (cores) with voids in the concrete between the members created by the ICF form as per Figure 2.1. It is also called an interrupted-grid wall or post-and-beam wall in other publications.

Seismic Load: The force exerted on a building structure resulting from seismic (earthquake) ground motions.

Seismic Design Categories: Designated seismic hazard levels associated with a particular level or range of seismic risk and associated seismic design parameters (i.e., spectral response acceleration and building importance). Seismic Design Categories A, B, C, D1, and D2 (Seismic Zones 0, 1, 2, 3, and 4) correspond to successively greater seismic design loads; refer to the IBC [5] and IRC [6].

Sill Plate: A horizontal member constructed of wood, steel, or other suitable material

that is fastened to the top of a concrete wall, providing a suitable surface for fastening structural members constructed of different materials to the concrete wall.

Slab-on-Grade: A concrete floor, which is supported by, or rests on, the soil directly below.

Slump: A measure of consistency of freshly mixed concrete equal to the amount that a cone of uncured concrete sags below the mold height after the cone-shaped mold is removed in accordance with ASTM C 143 [9].

Smoke-Development Rating: The combustibility of a material that contributes to fire impact through life hazard and property damage by producing smoke and toxic gases; refer to ASTM E 84 [10].

Span: The clear horizontal distance between bearing supports.

Stem Wall: A below-grade foundation wall supported directly by the soil or on a footing. Wall thickness and height are determined as that which can adequately distribute the building loads safely to the earth.

Stirrup: Steel bars, wires, or welded wire fabric located perpendicular to horizontal reinforcement and extending across the depth of the member in concrete beams, lintels, or similar members subject to large shear loads.

Story: That portion of the building included between the upper surface of any floor and the upper surface of the floor next above, except that the top-most story shall be that habitable portion of a building included between the upper surface of the top-most floor and the ceiling or roof above.

Story Above-Grade: Any story with its finished floor surface entirely above grade except that a basement shall be considered as a story above-grade when the finished surface of the floor above the basement is (a) more than 6 feet (1.8 m) above the grade plane, (b) more than 6 feet (1.8 m) above the finished ground level for more than 50 percent of the total building perimeter, or (c) more than 12 feet (3.7 m) above the finished ground level at any point.

Strap: Flat or coiled sheet steel material typically used for bracing and blocking which transfers loads by tension and/or shear.

Stud: Vertical structural element of a wall assembly, which supports vertical loads and/or transfers lateral loads.

Townhouse: Attached single-family dwelling units constructed in a row with each

unit separated by fire walls at property lines.

Track: A framing member consisting of only a web and two (2) flanges. Track depth measurements are taken to the inside of the flanges.

Truss: A coplanar system of structural members joined together at their ends usually to construct a series of triangles that form a stable beam-like framework.

Vertical Reinforcement: Steel reinforcement placed vertically in concrete walls to strengthen the wall against lateral forces and eccentric loads. In certain circumstances, vertical reinforcement is required for additional strength around openings.

***Waffle-Grid Wall*:** A solid concrete wall with closely spaced vertical and horizontal concrete members (cores) with a concrete web between the members created by the ICF form; refer to Figure 2.1. The thicker vertical and horizontal concrete cores and the thinner concrete webs create the appearance of a breakfast waffle. It is also referred to as an uninterrupted-grid wall in other publications.

Wall Height: The clear vertical distance between the finished floor and the finished ceiling. Where a finished floor does not exist (i.e., crawlspace), the wall height is the clear vertical distance between the interior finish grade and the finished ceiling.

Walls (steel):

Structural or Load Bearing: Wall systems subject to loads that exceed the limits for a non-structural system.

Non-Structural or Non-Load Bearing: Wall systems that are limited to a lateral (transverse) load of not more than 5 psf (240 Pa), a superimposed vertical load per member, exclusive of sheathing materials, of not more than 100 lb/ft (1460 N/m), or a superimposed vertical load per member of not more than 200 lbs (890 N).

Web: That portion of a framing member that connects the flanges.

Web Crippling: The localized permanent (inelastic) deformation of the web member subjected to concentrated load or reaction at bearing supports.

Web Stiffener: Additional material that is attached to the web to strengthen the member against web crippling. Also called a bearing stiffener.

Wind Exposure: refer to *Exposure Categories.*

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Wind Load: The force or pressure exerted on a building structure and its components resulting from wind. Wind loads are typically measured in pounds per square foot (psf) or Pascals (Pa).

Wind Speed: Wind speed is the design wind speed related to winds that are expected to be exceeded once every 50 years at a given site (i.e., 50 year-return period). Wind speeds in this document are given in units of miles per hour (mph) by "3-second gust" measurements (refer to Table 2.2 to convert to fastest-mile wind speed).

TABLE 2.2
EQUIVALENT BASIC WIND SPEEDS (mph)[1]

Fastest Mile	70	75	80	85	90	100	110
3-Second Gust	85	90	100	105	110	120	130

For SI: 1 mph = 1.609 km/hr = 0.447 m/sec
[1] Linear interpolation is permitted.

Yield Strength: A characteristic of the basic strength of the steel material defined as the highest unit stress that the material can endure before permanent deformation occurs as measured by a tensile test in accordance with ASTM A 370 [11].

Chapter 3

Materials, Shapes, and Standard Sizes

Insulating Concrete Forms

Connections between Insulating Concrete Form (ICF) systems and Cold-Formed Steel (CFS) framing in accordance with this document shall comply with the shapes and minimum concrete cross-sectional dimensions required in this section. Connections not in compliance with this section shall be used in accordance with the manufacturer's recommendations and as approved.

Flat ICF Wall Systems

Flat ICF wall systems shall comply with Figure 3.1 and shall have a minimum concrete thickness of 5.5 inches (140 mm) for basement walls and 3.5 inches (89 mm) for above-grade walls.

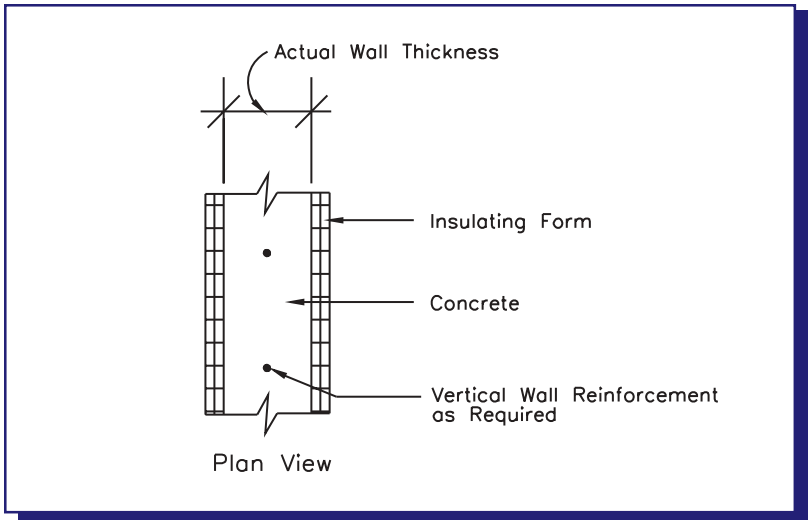


Figure 3.1. Flat ICF Wall Systems

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Waffle-Grid ICF Wall Systems

Waffle-grid ICF wall systems shall have a minimum nominal concrete thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The actual dimension of the cores shall comply with the dimensional requirements of Table 3.1 and Figure 3.2.

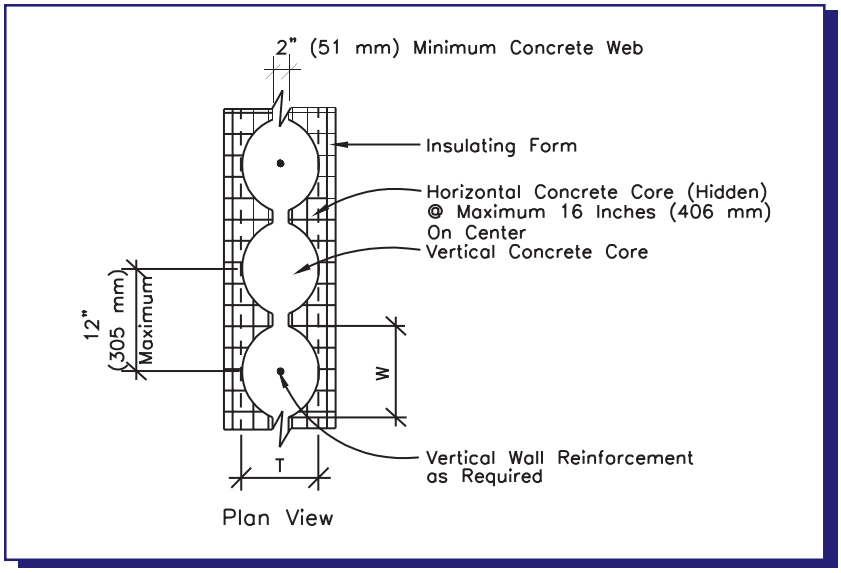


Figure 3.2. Waffle-Grid ICF Wall Systems

Screen-Grid ICF Wall Systems

Screen-grid ICF wall systems shall have a minimum nominal concrete thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The actual dimensions of the cores shall comply with the dimensional requirements of Table 3.1 and Figure 3.3.

TABLE 3.1
DIMENSIONAL REQUIREMENTS FOR CORES AND WEBS IN WAFFLE- AND SCREEN- GRID ICF WALLS

Nominal Size, (in)	Minimum Width of Vertical Core, (in)	Minimum Thickness of Vertical Core, (in)	Maximum Spacing of Vertical Cores, (in)	Maximum Spacing of Horizontal Cores, (in)	Minimum Web Thickness, (in)
Waffle-Grid					
6	6.25	5	12	16	2
8	7	7	12	16	2
Screen-Grid					
6	5.5	5.5	12	16	0

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

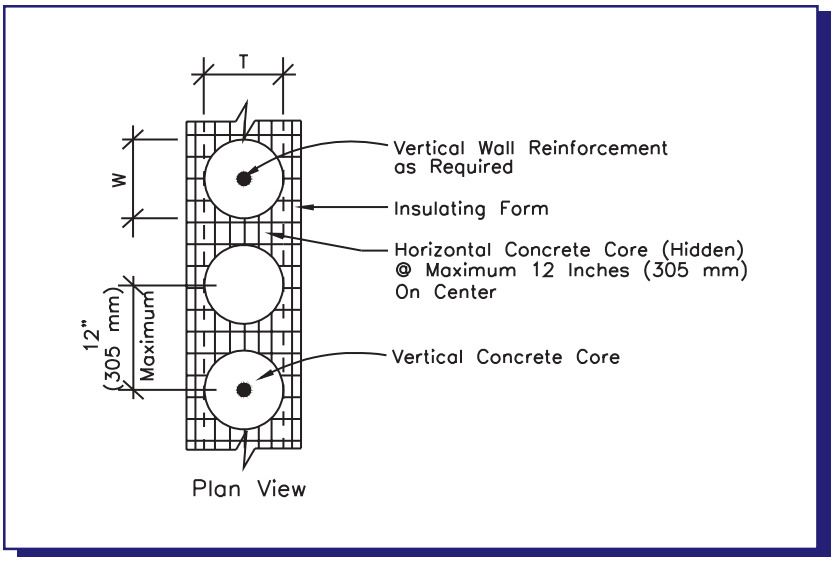


Figure 3.3. Screen-Grid ICF Wall Systems

Form Materials

Insulating concrete forms shall be constructed of rigid foam plastic meeting the requirements of ASTM C 578 [12], a composite of cement and foam insulation, a composite of cement and wood chips, or other approved material. Forms shall provide sufficient strength to contain concrete during the concrete placement operation. Flame-spread rating of forms shall be less than 75 and smoke-developed rating of forms shall be less than 450 tested in accordance with ASTM E 84 [10].

Concrete Materials

Concrete Mix

Ready-mixed concrete for ICF walls shall meet the requirements of ASTM C 94 [13]. Maximum slump shall not be greater than 6 inches (152 mm) as determined in accordance with ASTM C 143 [9]. Maximum aggregate size shall not be larger than 3/4 inch (19 mm).

Exception: *Maximum slump requirements may be exceeded for approved concrete mixtures resistant to segregation, meeting the concrete compressive strength requirements, and in accordance with the ICF manufacturer's recommendations.*

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Compressive Strength

The minimum compressive strength of concrete, f_c', shall be 2,500 psi (17.2 MPa) at 28 days as determined in accordance with ASTM C 31 [7] and ASTM C 39 [8]. For Seismic Design Categories D_1 and D_2 the minimum compressive strength of concrete f_c', shall be 3,000 psi.

Reinforcing Steel

Reinforcing steel used in ICFs shall meet the requirements of ASTM A 615 [14], ASTM A 616 [15], ASTM A 617 [16], or ASTM A 706 [17]. The minimum yield strength of the reinforcing steel shall be Grade 40 (300 MPa). Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system such that displacement will not occur during the concrete placement operation. Steel reinforcement shall have a minimum 3/4-inch (19-mm) concrete cover. Horizontal and vertical wall reinforcement shall not vary outside of the middle third of beams, columns, lintels, horizontal and vertical cores, and flat walls for all wall sizes.

Cold-Formed Steel

Material

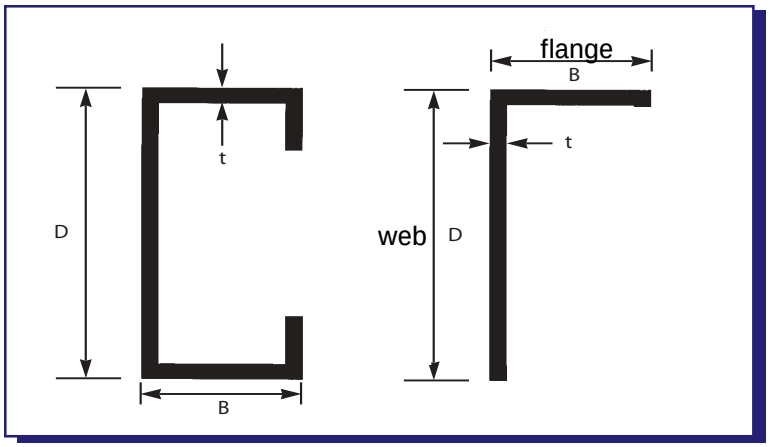
Structural and non-structural framing members utilized in steel construction shall be cold-formed to chape from sheet steel complying with the requirements of ASTM A1003/A1003M [23].

Corrosion Protection

Structural and non-structural framing members utilized in steel construction shall have a minimum metallic coating complying with the requirements of ASTM A1003/ A1003M [23]. Unless additional corrosion protection is provided, framing members shall be located within the building envelope and adequately shielded from direct contact with moisture from the ground or the outdoor climate. Dissimilar metals shall not be used in direct contact with steel framing members. Steel framing members shall not be embedded in concrete, unless approved for that purpose.

Fasteners shall have rust inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls



Member Designation

Member Designation

The standard designator defined in this section is used to identify framing members used in cold-formed steel construction. The designator consists of the following sequential codes:

A three or four-digit numerical indicating member web depth in 1/1000 inch. A letter indicating:

S = Stud or joist framing member which have lips
T = Track section
U = Channel or stud framing section which do not have lips
F = Furring channels
L = Angle or L-header

A three-digit numerical indicating flange width in 1/100 inch, followed by a dash. A two or three-digit numerical indicating base metal thickness in 1/1000 inch (mils).

Example: Designation for a 5 1/2"-16 gauge C-shape with 1 5/8" flanges: 550S162-54

550 S 162 -54
- 550: 5 1/2" member depth in 1/100th inches (outside-to-outside dimension)
- S: Stud or joist with flange stiffeners
- 162: 1 5/8" flange width in 1/100th inches
- -54: Minimum base metal thickness in mils (0.054 in. = 54 mils)

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Example: Designation for an 8"-18 gauge L-Header with 1 1/2" short leg:
2-800L150-43

800 L 150 -43

- -43: Minimum base metal thickness in mils (0.043 in. = 43 mils)
- 150: 1 1/2" width of short leg of angle in 1/100th inches
- L: Angle or L-header
- 800: 8" long leg of angle depth in 1/100th inches (outside-to-outside dimension)

Physical Dimensions

Cold-formed structural steel members shall comply with Figure 3.5 and the dimensional requirements specified in Table 3.2. Tracks shall comply with Figure 3.4 and shall have a minimum of 1-1/4 inch (32 mm) flanges. Members with different geometrical shapes shall not be used with these provisions without the approval of a design professional. Dimensional tolerances shall be in accordance with ASTM C955 [22] for load bearing members and ASTM C645 [21] for non-structural members.

TABLE 3.2
COLD-FORMED STEEL MEMBER SIZES

Member Designation[1]	Web Depth[2] (inches)	Minimum Flange Width[2,3] (inches)
350S162-t	3.5	1.625
550S162-t	5.5	1.625
800S162-t	8	1.625
1000S162-t	10	1.625
1200S162-t	12	1.625
350T125-t	3.5	1.25
550T125-t	5.5	1.25
800T125-t	8	1.25
1000T125-t	10	1.25
1200T125-t	12	1.25
600L150-t	6	1.50
800L150-t	8	1.50
1000L150-t	10	1.50

For SI: 1 inch = 25.4 mm.
[1] "t" indicates the bare metal thickness of the steel, expressed in mils.
[2] Web represents long leg size and flange represents short leg size for L-header angles.
[3] Maximum flange width is 2 inches; minimum lip size is 0.5 inches.

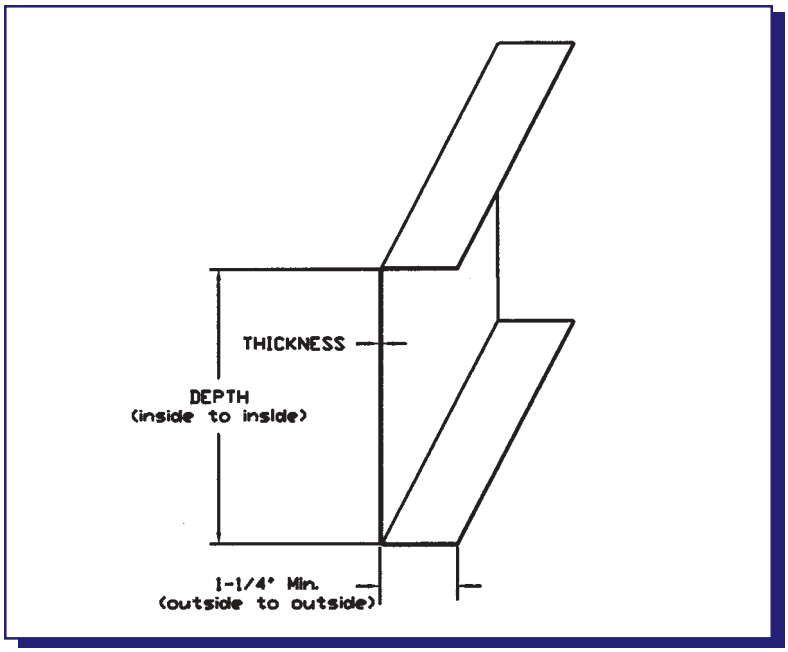


Figure 3.4. Track Section Dimensions

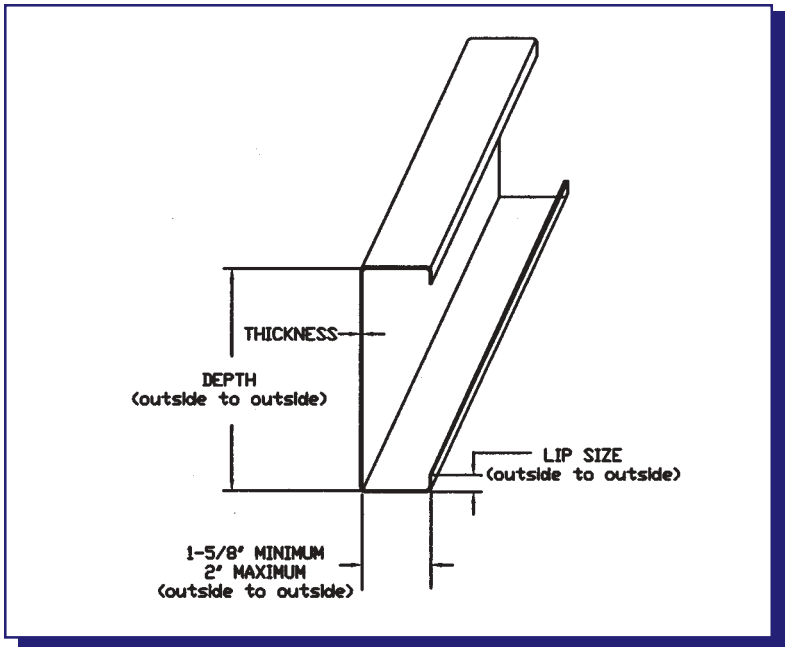


Figure 3.5. C-Shape Section Dimensions

Base Metal Thickness

The material thickness of framing members, in their end-use, shall meet or exceed the minimum base metal thickness values given in Table 3.3.

TABLE 3.3
MINIMUM BASE METAL THICKNESS OF COLD-FORMED STEEL MEMBERS

Designation (thickness in mils)	Minimum Base Metal Thickness, Inches (mm)[1]	Old Reference Gauge Number[2]
18	0.0179 (0.455)	25
27	0.0269 (0.683)	22
30	0.0296 (0.752)	20 - Drywall[1]
33	0.0329 (0.836)	20 - Structural[1]
43	0.0428 (1.09)	18
54	0.0538 (1.37)	16
68	0.0677 (1.72)	14
97	0.0966 (2.45)	12
118	0.1180 (3.00)	10

[1] Design thickness should be the minimum base metal thickness divided by 0.95.
[2] Gauge thickness is an obsolete method of specifying sheet and strip steel thickness. Gauge numbers are only a very rough approximation of steel thickness and shall not be used to order, design or specify any sheet or strip steel product.
[3] Historically, 20 gauge material has been furnished in two different thicknesses for structural and drywall (non-structural) applications.

Bend Radius

The maximum bend radius shall be the greater of the following:

- 3/32 inch (2.4 mm), or
- two times the material thickness (2t) but not greater than 1/8 inch (3.2 mm).

Yield Strength

The yield strength of steel members shall be determined in accordance with ASTM A370 [11]. Unless otherwise specified as 50 ksi (345 MPa), the minimum yield strength (or yield point) of cold-formed steel C-shapes, tracks, flat straps, and other members shall be 33 ksi (228 MPa).

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Product Identification

Framing members used in steel construction shall be identified with a ledgible sticker, stamp, stencil, or embossment, spaced a maximum of 48 inches (1220 mm) on center and located on the web of the framing member, in accordance with one of the following standards:

ASTM C645 (Non-structural framing members only)
ASTM C955 (Structural framing members only)
ASTM A1003/A1003M (Framing members not described in ASTM C645 or C955)

Performance of Steel in Homes

Steel-framing members located in an indoor atmosphere (such as wall and floor framing) have a very low rate of corrosion. Studies showed that the corrosion of zinc is lower than 0.1 µm per 3-year period in houses located in different rural, urban, marine, and industrial atmospheres. It can be concluded that a typical G40 zinc coated steel (10 µm = 0.39 mils) should outlast the life expectancy of a residential building.

Galvanized Steel in Contact With Building Materials

Contact With Other Metals

An electrochemical reaction occurs between dissimilar metals or alloys that can cause corrosion of one metal and protection of the other when they are in contact. This reaction will only occur when the dissimilar metals are connected in an electrolyte medium (such as moisture). In normal indoor environments, moisture levels are usually very low, and consequently, the galvanic action between dissimilar metals is much lower than those occurring in outdoor environments. Steel framing members are generally coated with zinc or aluminum alloy. Both zinc and steel will react adversely with brass and copper used for plumbing installations—this is known as a "galvanic reaction" or "galvanic corrosion" and can lead to durability problems just like other forms of corrosion. Steel Framing Alliance publication NT16-97, *Durability of Cold-Formed Steel Framing Members,* [24] provides detailed information on galvanized coatings in contact with building materials. Steel framing members can be easily isolated from other metals by plastic insulators or grommets.

Contact With Mortar and Plaster

Fresh mortar and plaster may attack zinc and zinc alloy coating when damp, but corrosion ceases when the materials dry.

Contact With Wood

Metallic coated steel does not react with dry wood. Dry pressure-treated lumber is also not corrosive to zinc, and no special requirements are needed to fasten steel to wood framing. Galvanized nails and screws have been successfully used to join wood and steel materials for years.

Contact With Drywall and Insulation Products

Drywall, mineral wool, cellulose, and rigid foam insulating products do not react with galvanized steel.

Contact With Concrete

Good quality chloride-free concrete is not corrosive to zinc once it has cured.

Bearing Stiffeners

A bearing stiffener (also referred to as web stiffener) shall be fabricated from a minimum 33 mil (0.84 mm) C-shaped member or 43 mil (1.09 mm) track member. Each stiffener shall be fastened to the web of the member it is stiffening with a minimum of four No. 8 screws equally spaced. Bearing stiffeners shall extend across the depth of the web and shall be installed on either side of the member.

Clip Angles

Clip angles shall have a minimum size of 2 inches x 2 inches by 33 mil (51 mm x 51 mm x 0.84 mm), unless otherwise noted. All clip angle materials shall comply with the following sections: “Structural Members,” “Yield Strength,” and “Corrosion Protection.”

Fasteners

Fastening cold-formed steel framing members can be accomplished using different methods and techniques. The most common methods of fastening steel to steel are

accomplished by screwing, welding, clinching, and nailing. Self-drilling, tapping screws are the most prevalent fasteners. Other fastening techniques, such as the use of pneumatically driven fasteners, powder-actuated fasteners, crimping, clinching, or welding, shall be permitted when approved. Screws are typically applied with a positive-clutch electric screw gun.

Screws

Holes are not typically drilled in steel framing before installing the screws. Therefore, self-drilling, self-tapping screws are the most common fasteners used to frame steel members. Screws are available in diameters ranging from No. 6 to No. 14, with No. 6 to No. 10 being the most common. Lengths typically vary from 1/2 inch (12 mm) to as much as 3 inches (76 mm) depending on the application. Screws are generally 3/8 inch (9.5 mm) to 1/2 inch (12.7 mm) longer than the thickness of the connected materials so that a minimum of three threads shall extend beyond the connected material. It is important that the drill point be as long as the material thickness being fastened to drill effectively. The correct fastener type and length for each application should be selected by consulting the screw manufacturer's specifications and catalogs.

Point Types

Two specific point types are commonly used, as shown in Figure 3.6:

- Self-Drilling Screws: Externally threaded fasteners with the ability to drill their own hole and form, or "tap," their own internal threads without deforming their own thread and without breaking during assembly. These screws are used with 33 mil (0.84 mm) steel or thicker.
- Self-Piercing Screws (sharp point): Externally threaded fasteners with the ability to pierce relatively thin steel material. They are commonly used to attach rigid materials, such as gypsum wallboard, to 33 mil (0.84 mm) or thinner steel.

For drill point screws, the total thickness of steel determines the point style of the screw to use. The larger the point style number and the larger the screw diameter, the more material the screw is capable of penetrating. Screw sizes should be selected based on the total thickness of the steel layers. While point styles 1, 4, and 5 are available, the most common are point styles 2 and 3.

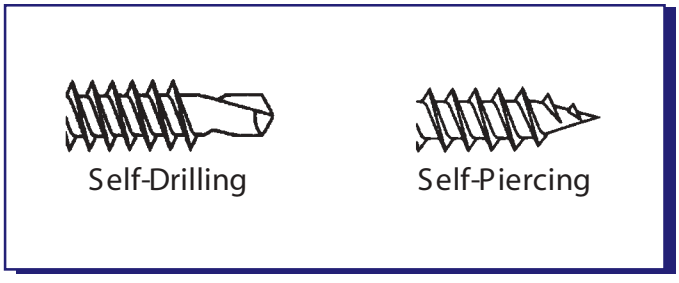


Figure 3.6. Screw Point Type

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Body Diameter

The body diameter of a screw is related to the nominal screw size as shown in Table 3.4. All connections shall be made with minimum of a No. 8 screw, except when attaching gypsum wallboard using a No. 6 screw.

TABLE 3.4
SCREW BODY DIAMETER

Screw Nominal Size	Nominal Screw Diameter, d, in.
No. 6	0.1380
No. 8	0.1640
No. 10	0.1900
No. 12	0.2160
1/4"	0.2500

For SI: 1 inch = 25.4 mm.

Length

The length of a screw is measured from the bearing surface of the head to the end of the point as shown in Figure 3.7. For example, the length of a flat or countersunk head is measured from the top of the head to the end of the point. A pan head screw length is measured from under the head (bearing surface) to the end of the point.

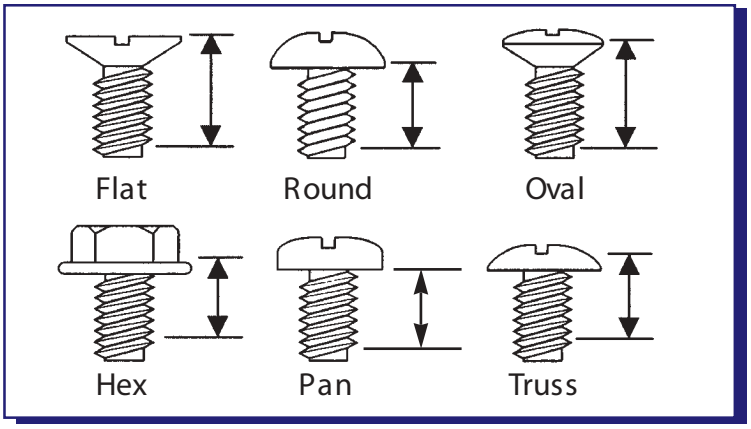


Figure 3.7. Screw Length Measurements
Reprinted by permission of Light-Gauge Steel Engineers Association

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

The length of self-drilling screws may require special consideration since some designs have an unthreaded pilot section or reamer with wings between the threads and the drill point as shown in Figure 3.7. These features may be necessary for certain applications, such as applying wood sheathing to a steel floor joist. The long pilot point or reamer (see Figure 3.8) is required to allow the screw to drill through the material before engaging the threads. If the threads engage before the pilot hole is drilled completely, a gap may result in the connection. This can result in a squeaky connection or “screw-pops” through certain finish materials.

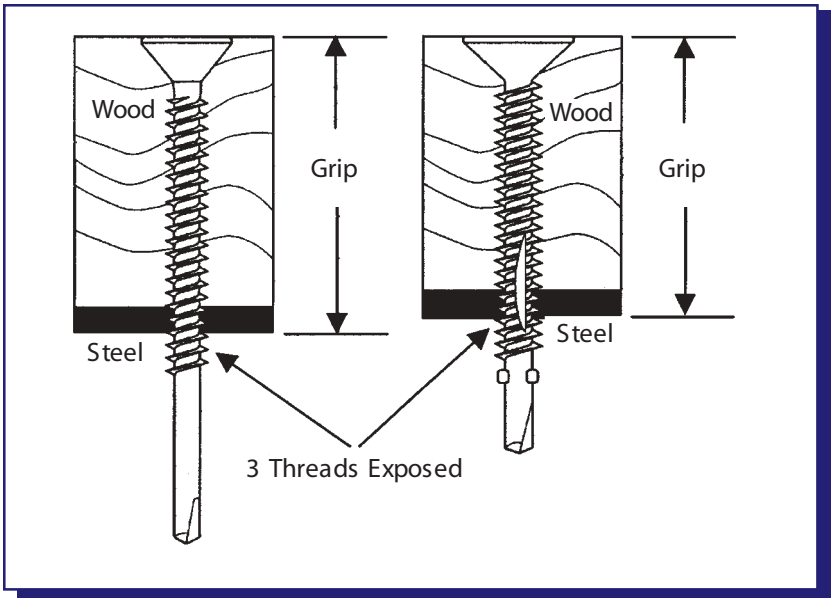


Figure 3.8. Screw Grip Range
Reprinted by permission of Light-Gauge Steel Engineers Association

Thread

Self-piercing and self-drilling screws intended for cold formed steel applications generally have a coarse thread (e.g., 10-16 x 5/8 HWH SD indicates a 10 diameter, 16 threads per inch, 5/8" length, hex washer head, self-drilling screw). Self-drilling screws with fine threads are permitted. Manufacturer recommendations should be followed.

Corrosion Resistance

Common platings for corrosion resistance include zinc (mechanical galvanizing),

phosphate and oil, and zinc with a yellow dichromate finish (gold color appearance). Self-drilling screws are typically zinc plated.

Screw Head Types

The screw head locks the screw in place and prevents it from sinking into the fastened material, and it draws the fastened material together. Common head styles include flat, oval, wafer, truss, modified truss, hex washer, pan, round washer, and pancake. See Figure 3.9. The specified style shall be determined by the application, preference, and availability. However, hex head screws are typically used for heavier structural connections. Round washer screws are typically used for general framing connections. Low profile heads are used on surfaces to be finished with gypsum board. And bugle head screws are typically used to attach sheathing products.

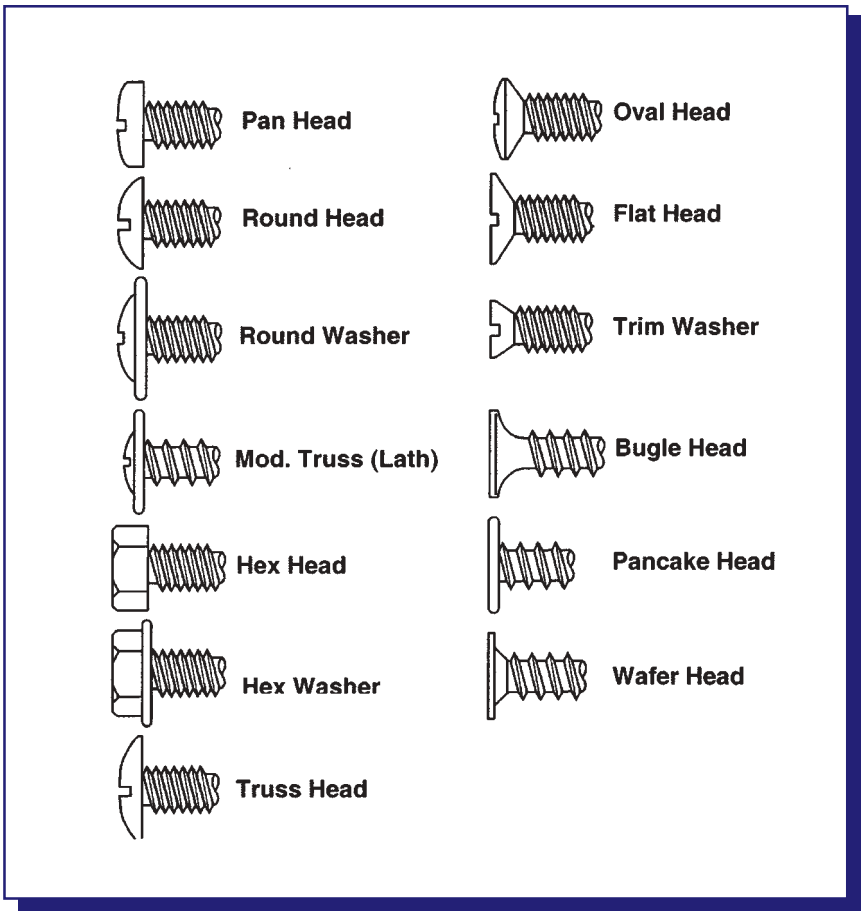


Figure 3.9. Screw Head Types
Reprinted by permission of Light-Gauge Steel Engineers Association

Drive Types

Availability and preference determines drive types. Common drive types are shown in Figure 3.10.

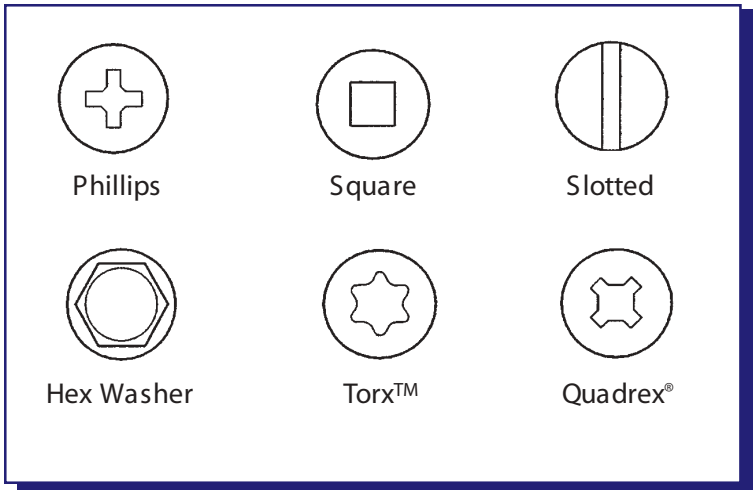


Figure 3.10. Screw Drive Types
Reprinted by permission of Light-Gauge Steel Engineers Association

Screw Requirements

For all connections, screws shall extend through the steel a minimum of three exposed threads as shown in Figures 3.11 and 3.12. Screws shall penetrate individual components of a connection without causing permanent separation between the components. Screws shall be installed in a manner such that the threads and holes are not stripped. Self-drilling tapping screws shall have a coating of 3 microns of zinc, or satisfy a 24-hour salt spray test (ASTM F1941) [25] or equivalent corrosion protection. Where No. 8 screws are specified in a steel-to-steel connection, the required

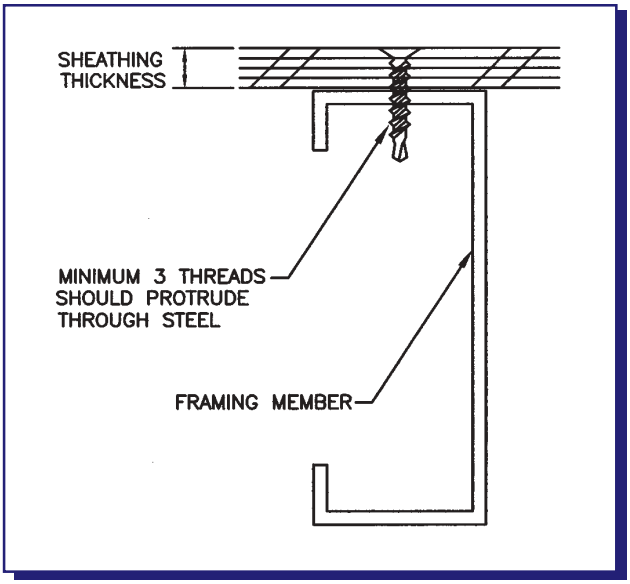


Figure 3.11 Floor Sheathing-to-Steel Connection
Reprinted by permission of Light-Gauge Steel Engineers Association

number of screws in the connection is permitted to be reduced in accordance with the reduction factors in Table 3.6 when larger screws are used or when one of the sheets of steel being connected is thicker than 33 mils (0.84 mm). When applying the reduction factor, the resulting number of screws shall be rounded up.

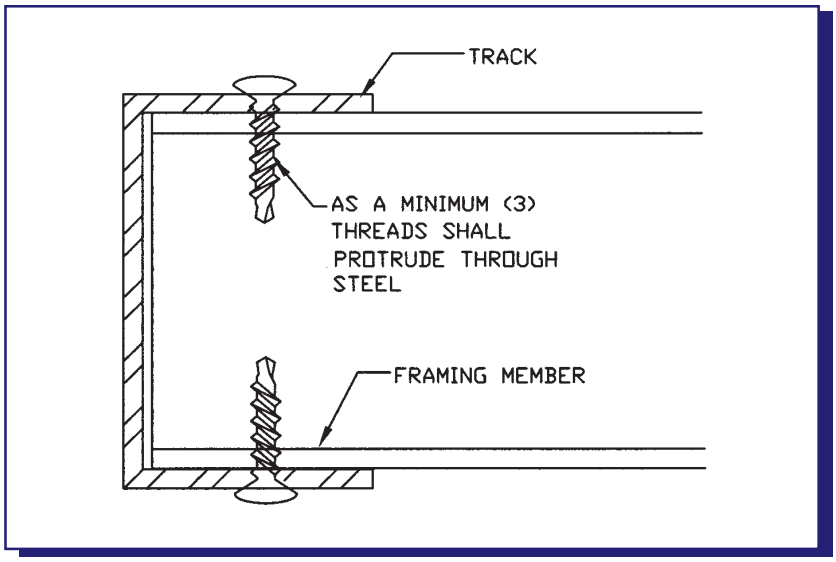


Figure 3.12. Steel-to-Steel Screw Connection
Reprinted by permission of Light-Gauge Steel Engineers Association

TABLE 3.5
SCREW SUBSTITUTION FACTOR

Screw Nominal Size	Thinnest Connected Steel Sheet (mil)	
	33	43
No. 8	1.0	0.67
No. 10	0.93	0.62
No. 12	0.86	0.56

For SI: 1 inch = 25.4 mm.

Steel-to-Steel Connections

Screws for steel-to-steel connections shall be installed with a minimum edge distance and center to center spacing of 1/2 inch (13 mm), and shall be self-drilling tapping in compliance with SAE J-78 [26].

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls

Structural Sheathing to Steel Connections

Structural sheathing shall be attached to steel framing (i.e., studs and joists) with minimum No. 8 self-drilling tapping screws in compliance with SAE J-78 [26]. Screws attaching structural sheathing to steel joists and wall framing shall have a minimum head diameter of 0.292 inch (7 mm) with countersunk heads and shall be installed with a minimum edge distance of 3/8 inch (9 mm).

Gypsum Board to Steel Connections

Gypsum board shall be attached to steel framing with minimum No. 6 screws conforming to ASTM C954 [27] and shall be installed in accordance with the applicable building code requirements for interior wall and ceiling finishes.

Drive Pins and Nails

Pneumatic pins and nails are specifically designed with spiral grooves or knurls on the nail shaft to penetrate the steel. Drive pins and nails are typically used with airguns. Drive pins and nails are primarily used in attaching wood sheathing to wall and roof framing. Care should be taken and manufacturer's recommendations should be followed carefully when fastening subflooring to joists using drive pins and nails, in order to prevent the assembly from creating noise.

Bolts

Bolts are used in cold-formed steel framing when required to anchor a floor or a wall to foundations. The most common anchors used in steel construction are anchor bolts, mudsill anchors, anchor straps, mushroom spikes, and powder-actuated anchors. Bolts shall meet or exceed the requirements of ASTM A307 [28]. Washers and nuts shall be properly installed and tightened. Bolts connecting steel framing to concrete shall have bolt holes spaced no closer than three bolt diameters on center. The distance from the center of the bolt hole to the edge of the connecting member shall not be less than one and one-half bolt diameters.

Prescriptive Method for Connecting Cold-Formed Steel Framing to Insulating Concrete Form Walls