Cover Sheet

█████ █████████ Ct. Hemet, Ca. 92545

3RD Car Garage Conversion To Home Office

Owners: ████████ & █████████ ████████

Contractor: ███████████████████████████
███████████████ Hemet, ca. 92545
████████████ Ph.
████████████ Fax

Contact: ███████████████████████
██████████████████████████████

Table of Contents:

1

W. Esplanade Ave
W. Esplanade Ave
Warren Rd
Alabaster Ave
Turnstone Ct
Ravenstone Dr
Satinstone Dr
Shadestone Dr
Sagestone Dr
Cinnabar Ave
Inglestone Dr
Alabaster Ave
Arrowstone Ln
Silkstone Dr
Berylstone Dr
Sepstone Ct
Cragstone Dr
Spicestone Dr
Riverstone Ct
Silkstone Dr
Topstone Dr
Swingstone Dr
Crow Area

N

⊠ : 5380 Circlestone CT
Hemet, CA. 92545

NOTES

1. NEW SUB FLOOR IS TO BE LEVEL WITH NO ELEVATION CHANGE TO HALL 1, AND A MAX. DROP INTO GARAGE OF 3"

2. INSULATE SUB FLOOR BAY'S w/ R-13 INSULATION FOR NOISE REDUCTION

3. ANY LUMBER THAT WILL BE IN DIRECT CONTACT WITH CONCRETE MUST BE PRESERVATIVE TREATED LUMBER

4. ALL DRYWALL SHALL BE 5/8" TYPE X. SCREWED OFF WITH A 6/12 PATTERN

5. NEW SMOKE DETECTORS MUST BE HARD WIRED IN SERIES WITH EXISTING SMOKE DETECTORS

6. GARAGE DOOR OPENER BUTTON IS TO BE RE-LOCATED

7. NEW 3068 DOOR FROM OFFICE TO GARAGE SHALL BE FIRE RATED WITH SELF CLOSING HINGES, WEATHER SEAL, DOUBLE LOCKING, THRESHOLD, AND A THICKNESS OF 1¾"

8. ALL 15 AND 20 AMP 120 VOLT OUTLETS SHALL BE ARC-FAULT PROTECTED IN OFFICE

9. CEILING FAN AND LIGHT FIXTURE ARE TO BE SWITCHED SEPERATELY

10. ALL 15 AND 20 AMP 120 VOLT RECEPTACLE OUTLETS MUST BE TAMPER RESISTANT

11. APPROXIMATELY 20' OF NEW DUCTING WILL BE ADDED

12. UNDER FLOOR VENTILATION SHALL MEET 1 SQ. FT PER 150 SQ. FT. OF UNDER FLOOR AREA

PROPERTY ADDRESS:
▓▓▓▓▓▓▓▓▓▓ CT.
HEMET, CA. 92545

PROPERTY OWNERS:
▓▓▓▓▓▓▓▓▓▓

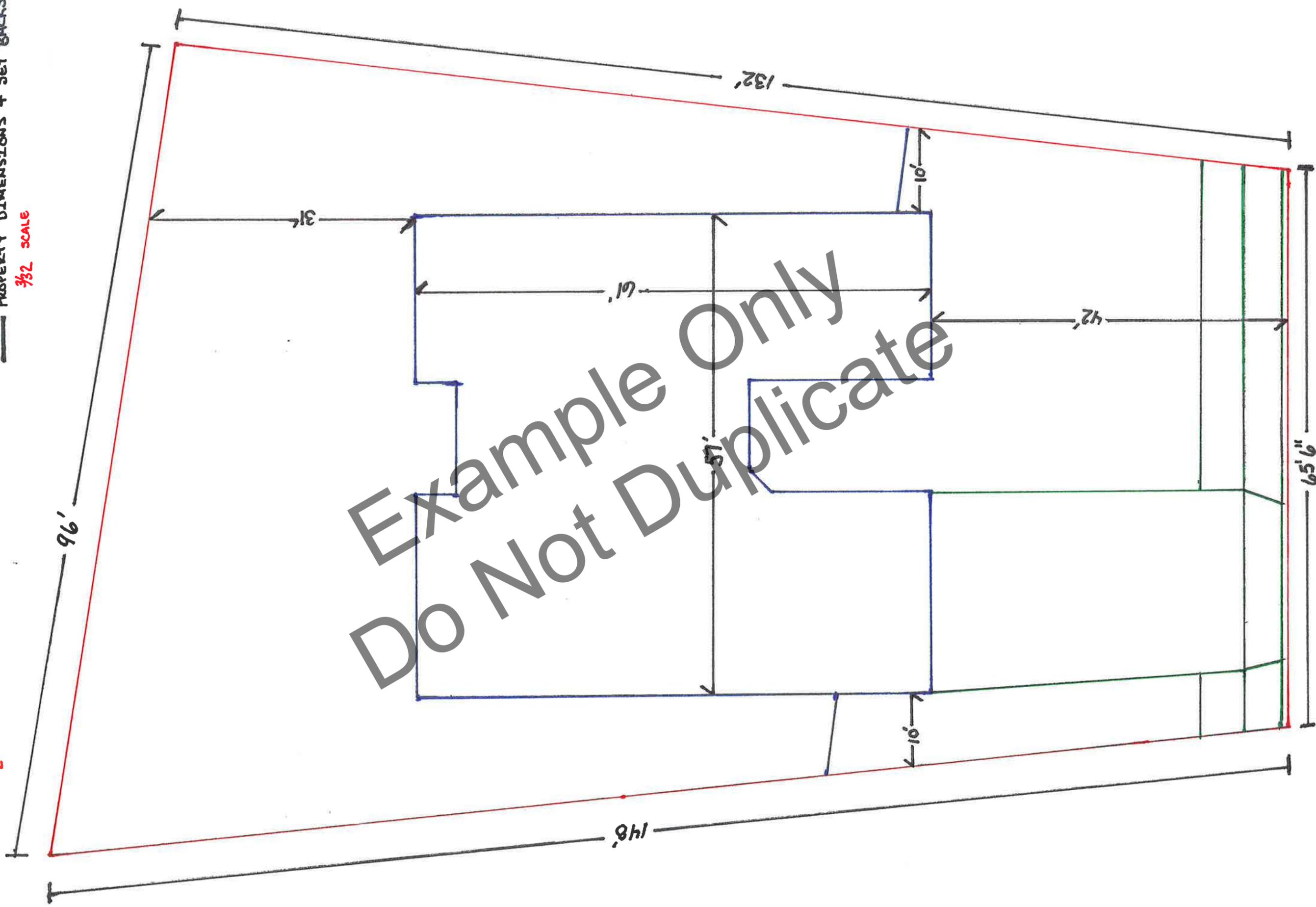GENERAL CONTRACTOR:
▓▓▓▓▓▓▓▓▓▓
PH.
FAX

DRAWINGS BY:
▓▓▓▓▓

13. WHERE A PERMIT IS REQUIRED FOR ALTERATIONS EXCEEDING $1,000.00, EXISTING DWELLINGS THAT HAVE ATTATCHED GARAGES OR FUEL BURNING APPLIANCES SHALL BE PROVIDED WITH CARBON MONOXIDE ALARMS IN ACCORDANCE WITH SECTION 315.1 SEE PG. 7 (CM)

14. SPECIAL INSPECTION REQUIRED FOR INSTALLATIONS OF ALL RED HEAD WEDGE ANCHORS AND TAP-CON FASTNERS

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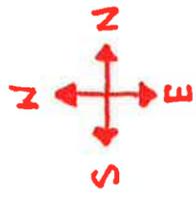
EXISTING STRUCTURE + BLOCK WALL

EXISTING SIDE-WALK + DRIVE-WAY

PROPERTY LINES

PROPERTY DIMENSIONS + SET BACKS

3/32 SCALE

5380 Firestone Ct.

Hemet, CA. 92545

N
W — E
S

132'

31'

10'

19'

42'

17'

10'

65' 6"

96'

148'

DIMENSIONED SITE PLAN W/ P.L., STRUCTURE + SET BACKS   3/32 SCALE

④

MASTER BED

BED 3

BED 2

MASTER BATH

HALL 2

BED 1

CLOSET

BATH 2

F.P.

ENTRY

FAMILY

NOOK

KITCHEN

DEN

LAUNDRY

GARAGE

HALL 1

LIVING

BATH 1

GARAGE

F.P.

5280 Tolestane Ct
Hemet, CA. 92545

N
W — E
S

ORIGINAL EXISTING FLOOR PLAN 3/16 SCALE

⑤

5380 EGGLESTONE CT.
HEMET, CA. 92545

N E S W (compass)
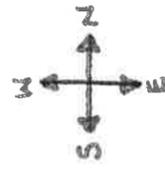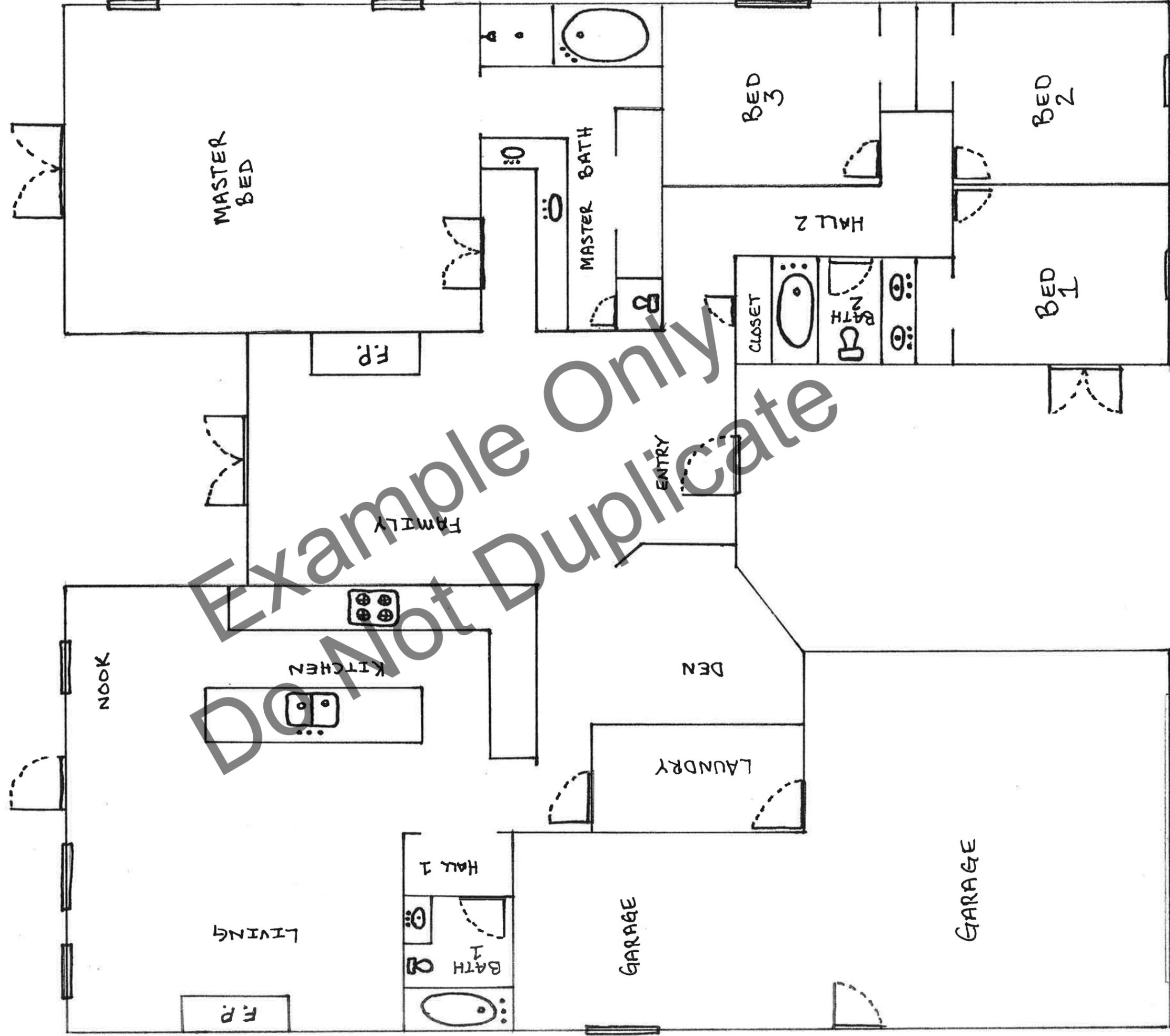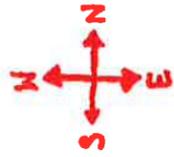
① FRAME IN R.O. FOR NEW DOOR USING A 4x4 HEADER BETWEEN EXISTING KING STUDS, ATTACHED w/ SIMPSON STRONG TIE A-35. AND MIN. OF 2 TRIMMERS

② EGRESS WINDOW 36" A.F.F. WITH LEFT TO RIGHT OPENING GLIDER PANEL WITH AN OPENING OF 27"x43" LOW E GLASS. WITH AN EXTERNAL LANDING 36" ABOVE FINISH GRADE AND A CLEARANCE OF 10'

③ 2668 HOLLOW CORE 6 PANEL DOOR 1 3/8" DOOR THICKNESS

④ 3068 SOLID CORE, FIRE RATED, SELF CLOSING, DOUBLE LOCKING DOOR WITH A THICKNESS OF 1 3/4"

ENTRY

DEN

LAUNDRY

2668

2668

GARAGE

OFFICE
8'10" ceiling Hr.

HALL 1

BATH 1

LIVING

2668

2668

3068

2668

20'

21'

11'

8'

3'

7½'

4'

EXISTING 4636 SH

4630 SH ②
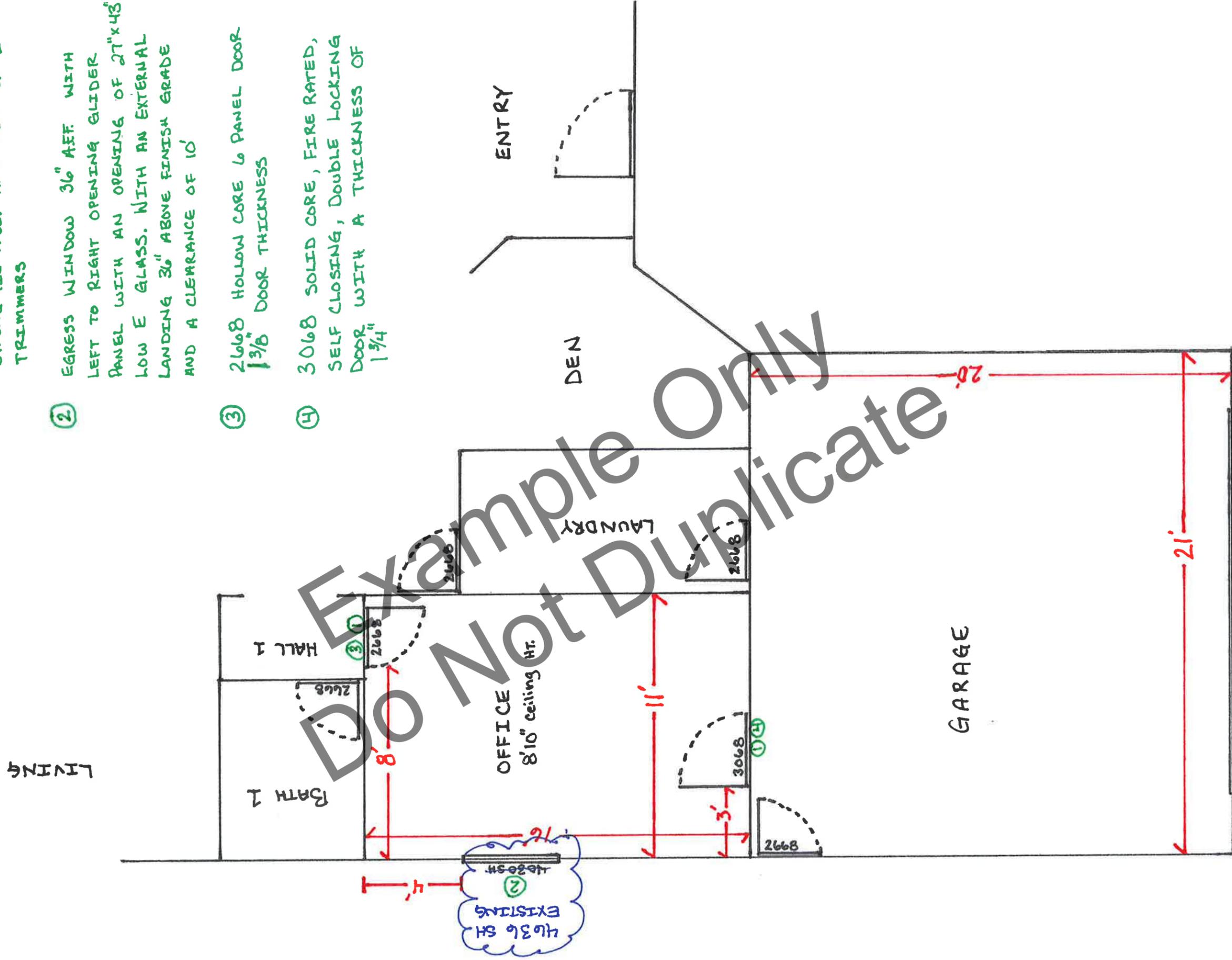
OFFICE/GARAGE DIMENSIONS

SCALE : ¼" = 1'

⑥

LAUNDRY

HALL

BATH 1

OFFICE

GARAGE

REG.

5380 CIRCLESTONE CT

HEMET, CA. 92545

~ NEW 3-WAY LIGHT

3-WAY TO HALL LIGHT

12-2 OF NEW AIR DUCT

3-WAY LIGHT SWITCH

3-WAY FAN SWITCH

3-WAY LIGHT SWITCH

3-WAY FAN SWITCH

3-WAY GARAGE SWITCH

3-WAY GARAGE LIGHT SWITCH

EXISTING GARAGE LIGHT SWITCH

12-2 HOMERUN TO PANEL
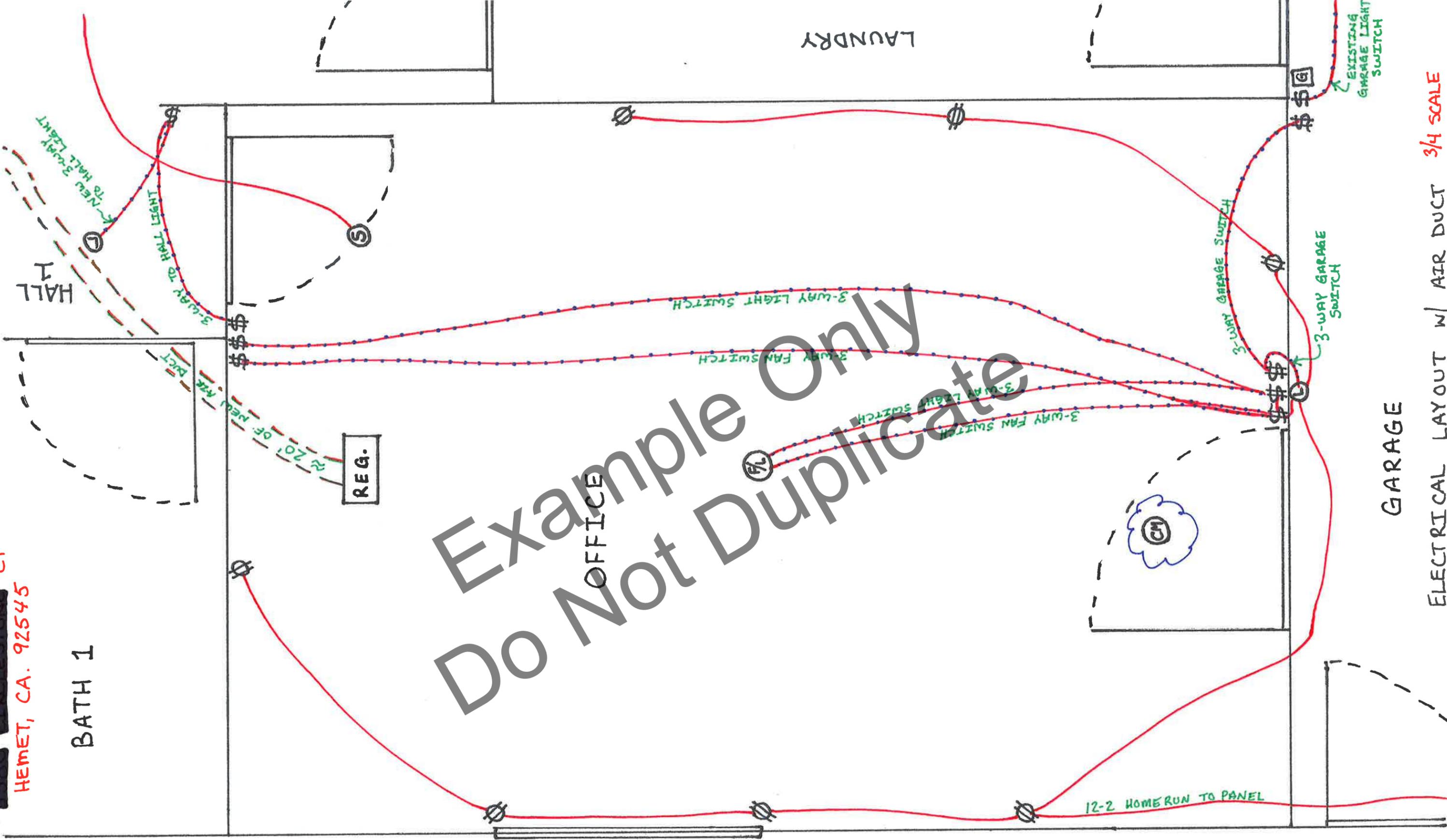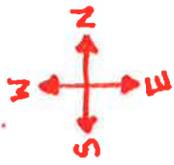
ELECTRICAL LAYOUT w/ AIR DUCT   3/4 SCALE

N W E S

⑦
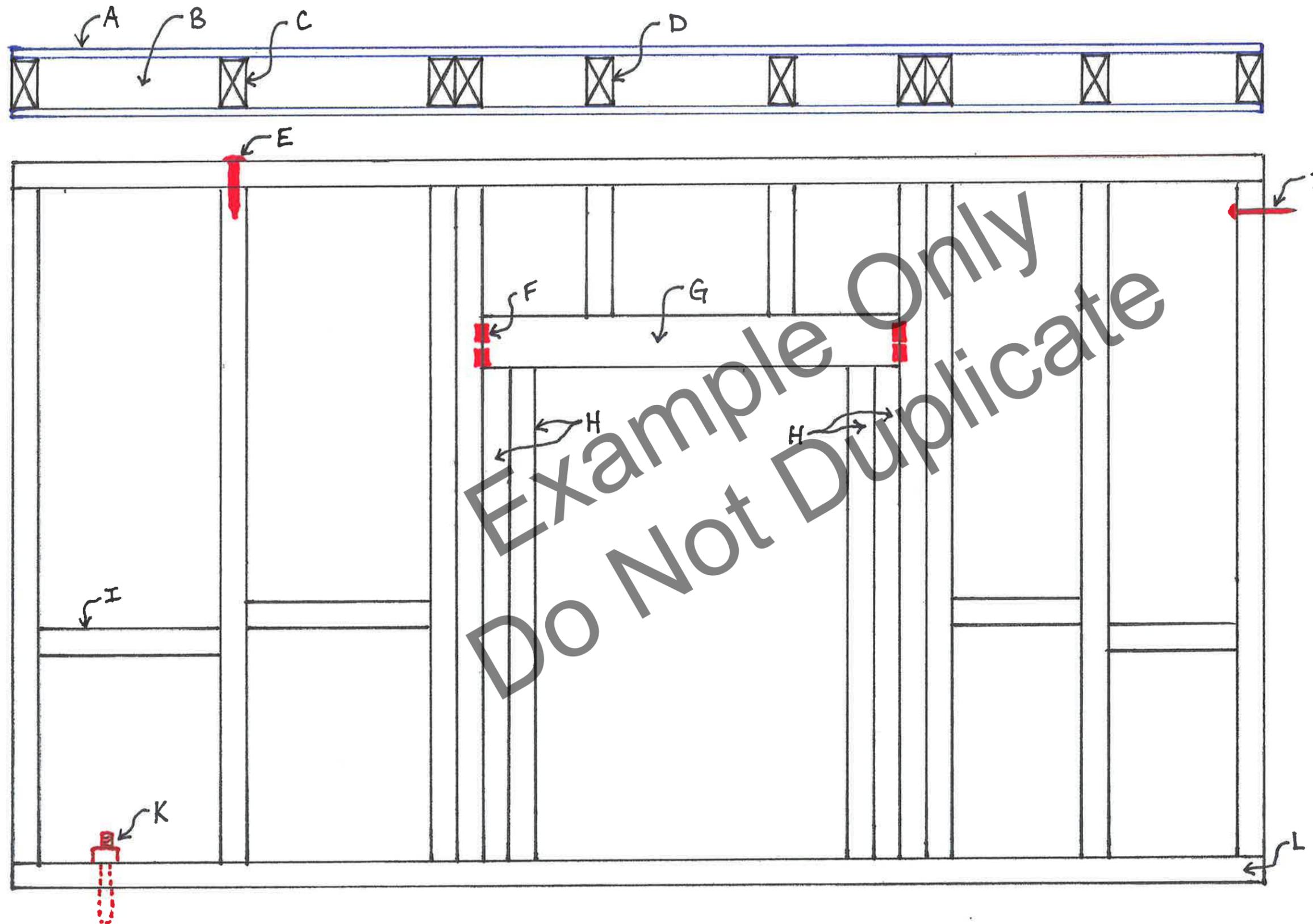
NOTES:

A: 5/8" TYPE X DRY WALL SCREWED @ 6/12 PATTERN

B: R-13 INSULATION TYP.

C: 2×4 STUDS @ 16" O.C.

D: 2×4 CRIPPLE ABOVE HEADERS

E: 16d NAIL THRU TOP PLATE INTO STUD × 2

F: A-35 SIMPSON HARDWARE @ HEADER LOCATIONS TYP.

G: 4×4 HEADER TYP.

H: 2×4 TRIMMER (4 PER HEADER)

I: FIRE BLOCK @ 44" - 48" O.C. IN EACH BAY.

J: 16d NAIL TO CONNECT NEW WALL TO EXISTING ADJACENT WALL WITH A STAGGERED 8" PATTERN

K: 1/2" × 3¾" HOT DIPPED ZINC COATED RED HEAD FASTNER. (SEE ATTACHED ICC REPORT ESR-2427)

L: PRESERVATIVE 2×4 BOTTOM SILL PLATE

NEW WALL AND HEADER DETAILS   NOT TO SCALE

⑧

SEE ICC REPORT FOR MORE SPECS.
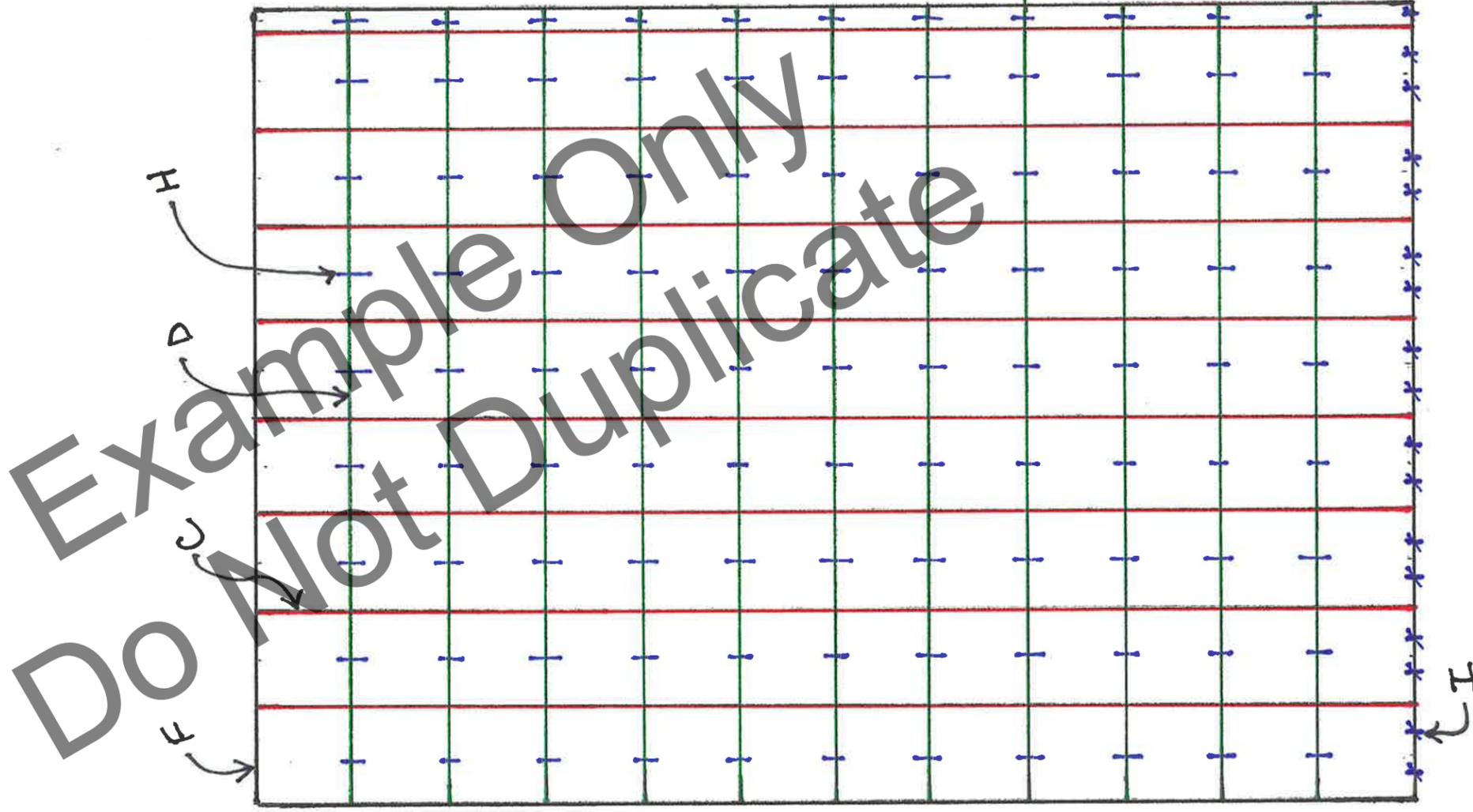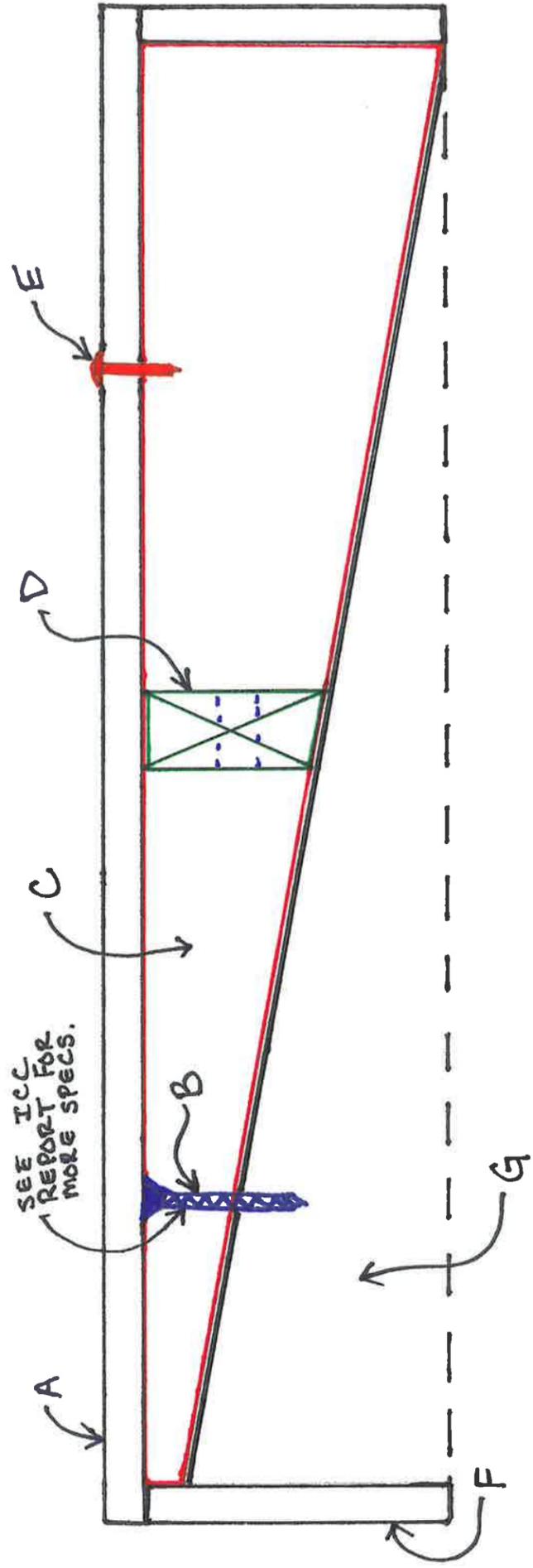
NOTES:

A: 1" T+G PLYWOOD SUB FLOOR SHEET

B: 1/4" TAPCON FASTNER @ 24" O.C. w/ MIN. EMBEDEMENT TO CONCRETE OF 1½"

C: 2×4 PRESERVATIVE LUMBER @ 16" O.C. CUT ON ANGLE TO ACHIEVE LEVEL FLOOR

D: 2×4 PRESERVATIVE LUMBER PAD BLOCK @ 16" O.C.

E: 10d NAIL TYP. @ 6" EDGE & 12" FIELD PATTERN

F: EXISTING STEM WALL

G: EXISTING SLAB

H: 1" HOLE DRILLED thru PAD BLOCK FOR VENTILATION

I: 1" HOLE thru WALL WITH MESH SCREEN BACKING FOR SUB VENTILATION

SUB FLOOR DETAILS

NOT TO SCALE

9

5280 KINGLESTONE CT.
HEMET, CA. 92545

N / W E / S

HALL 1

OFFICE

SECTION A

2668 INTERIOR DOOR LANDING DETAIL
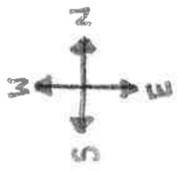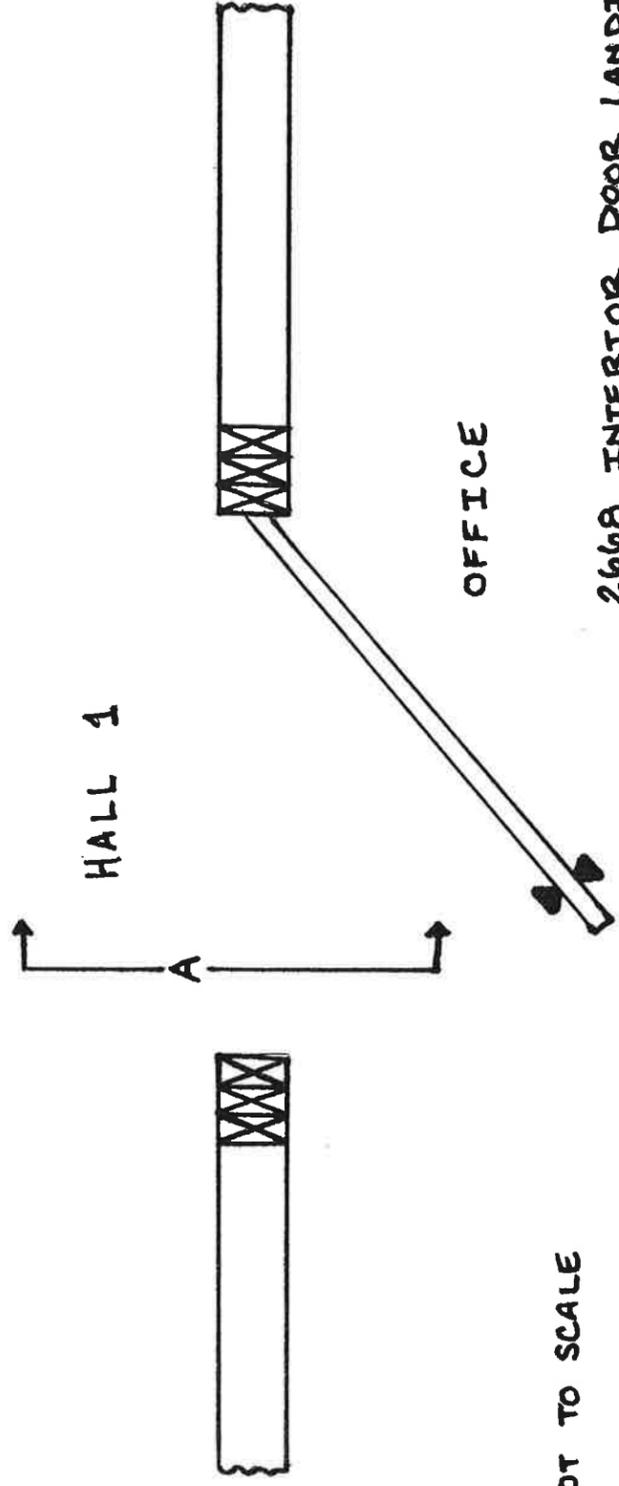
NOT TO SCALE

HALL 1

OFFICE

2668 INTERIOR DOOR LANDING SECTION

NOT TO SCALE
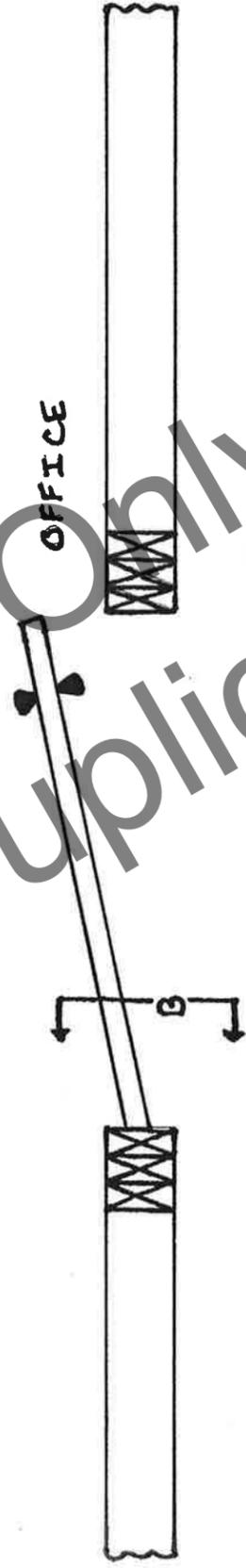
OFFICE

GARAGE

SECTION B

3068 FIRE DOOR LANDING DETAIL

NOT TO SCALE

GARAGE

OFFICE

DIMENSION "Y" NOT TO EXCEED 1" MAX.

DIMENSION "X" NOT TO EXCEED 3" MAX

3068 FIRE DOOR LANDING SECTION

NOT TO SCALE

DOOR LANDING DETAILS   NOT TO SCALE

10

Tapcon® Concrete Screws

- Tapcon® Concrete Screws Overview
- Installation - Video
- Technical Specifications
- Frequently Asked Questions
- Product Sizes & Pricing
- Purchase Tapcon® Concrete Screws
- Return to Main Products Page

Questions about purchasing online? Please feel free to call us at: 1.800.966.9617.

View our return policy

| Product Sizes & Pricing | Purchase Tapcon® Concrete Screws |

Use with the following base materials:

| Concrete | Brick | Block | Mortar |

Applications:

Light to Medium Duty

Features of the Tapcon® Concrete Screw:

- Fast installation...drill a hole...drive an anchor
- Standard 3/16" and 1/4" blue Tapcons are packaged with one Tapcon® "close tolerance" masonry drill bit per 100 anchors
- Available in 3/16" and 1/4" diameters and in lengths of 1-1/4" to 6"
- Large diameter Tapcon® sizes available – 3/8", 1/2", 5/8" and 3/4"
- 1/4" Tapcon® uses a 3/16" dia. bit and 3/16" Tapcon® uses a 5/32" dia. bit
- Replaces small diameter expansion anchors, plugs and screws in light to medium duty applications
- No need to pre-spot holes...and no inserts are required
- Tapcons are reversible and removable...can be installed close to an edge
- The minimum embedment requirement is 1" and the maximum embedment is 1-3/4"
- Two head styles – Hex washer slotted and flat countersunk Phillips
- Stainless steel Tapcons are available – 3/16" and 1/4" diameter Flat, 1/4" diameter Hex, and 1/2" and 3/8" Large Diameter
- Tapcons are acceptable for use with ACQ treated lumber

Also known as:

Concrete Screw	The Original Tapcon	Masonry Screw
Self Tapping Concrete Screw	Blue Screw	Consert Screw
Confast Screw	Kwik-con	Con-sert Screw
Tapper	Ruff-nex	Cement Screw
Stainless Steel Concrete Screw	Titan	

Installing Tapcon® Concrete Screws
View our Tapcon® installation video and follow these four easy steps to install your Tapcon® Screws into concrete, brick or block.

Tapcon® Technical Specifications
View technical information such as tension and shear values for Tapcons, Large Diameter Tapcons and Stainless Steel Tapcon® Screws.

Frequently Asked Questions
Still have questions or just want to find out more about Tapcon® Screws? Click here to see what others have been asking about Tapcons and read our responses.

Tapcon® Product Sizes & Pricing
Click here for a list of Tapcon® sizes, part numbers and pricing.

Purchase Tapcon® Concrete Screws
Click here if you have found what you are looking for and are ready to place your order for Tapcon® Screws, Installation Kits and Drill Bits.

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Terms of Use	Product Disclaimer

Tapcon® Concrete Screws

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Technical Specifications — Tapcon® Concrete Screws

There are numerous technical specifications that must be considered when using Tapcon® screws. Determinations must be made on the diameter of the Tapcon® - standard or large diameter, length of the Tapcon® - ranging from 1-1/4" to 6", head style - hex slotted or flat phillips, material or coating - Blue Climaseal®, Zinc Plated Large Diameter, Envirex Coated Large Diameter or Stainless Steel, embedment depth - 1" minimum to 1-3/4" maximum, and type of base material - concrete, brick or block. Once all of these factors have been determined, you can find the expected holding values in the technical information below.

Tapcon® Anchor Length:

To determine the minimum length of Tapcon® Screw required, add the thickness of the material to be fastened and the minimum embedment (1"). To determine the maximum length of Tapcon® Screw required, add the thickness of the material to be fastened and the maximum embedment (1-3/4").

Tapcon® Anchor Spacing:

Allowable Edge and Spacing Distances - in NORMAL WEIGHT CONCRETE

Parameter	Anchor Diameter (inches)	Full Capacity (Critical Distance) (inches)	Reduced Capacity (Minimal Distance) (inches)	Load Reduction Factor
Edge Distance - Tension	3/16	1-7/8	1	.71
	1/4	2-1/2	1-1/4	.78
Edge Distance - Shear	3/16	2-1/4	1-1/8	.70
	1/4	3	1-1/2	.59
Spacing between Anchors - Tension	3/16	3	1-1/2	.73
	1/4	4	2	.66
Spacing between Anchors - Shear	3/16	3	1-1/2	.83
	1/4	4	2	.82

Allowable Edge and Spacing Distances - in BLOCK

Parameter	Anchor Diameter (inches)	Full Capacity (Critical Distance) (inches)	Reduced Capacity (Minimal Distance) (inches)	Load Reduction Factor
Edge Distance - Tension	3/16	4	2	.91
	1/4	4	2	.88
Edge Distance - Shear	3/16	4	2	.93
	1/4	4	2	.90
Spacing between Anchors - Tension	3/16	3	1-1/2	1.00
	1/4	4	2	.84

Spacing between Anchors - Shear			
3/16	3	1-1/2	1.00
1/4	4	2	81

Tapcon® Ultimate Holding Values** - in NORMAL WEIGHT CONCRETE

Blue Climaseal Tapcon®

Anchor Diameter (inches)	Embedment Depth (inches)	2000 PSI Concrete		4000 PSI Concrete	
		Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)
3/16	1	600	720	650	720
	1-1/2	1090	860	1090	860
	1-3/4	1450	870	1460	990
1/4	1	750	900	800	1360
	1-1/2	1380	1200	1820	1380
	1-3/4	2020	1670	2380	1670

Stainless Steel Tapcon®

Anchor Diameter (inches)	Embedment Depth (inches)	3000 PSI Concrete	
		Tension (lbs.)	Shear (lbs.)
3/16	1	964	
	1-1/4	1080	1460
	1-3/4	1595	
1/4	1	1381	
	1-1/4	1616	1622
	1-3/4	2332	

Large Diameter Tapcon® - Zinc & Stainless Steel

Anchor Diameter (inches)	Embedment Depth (inches)	2000 PSI Concrete		4000 PSI Concrete	
		Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)
3/8	1-1/2	1336	2108	1068	3416
	2	1492	3036	2552	3420
	3	5396	3312	7852	3428
1/2	2	3580	5644	4236	7380
	3-1/2	7252	6436	8836	8140
	4-1/2	10176	7384	10488	8552
5/8	2-3/4	5276	8656	7844	13476
	3-1/2	7972	10224	11724	14060
	4-1/2	11568	12316	16892	14840
3/4	3-1/4	6876	7140	12636	14316
	4-1/2	10304	13120	18540	20612
	5-1/2	13048	17908	23268	25652

Tapcon® Ultimate Holding Values** - in BLOCK

Blue Climaseal Tapcon®

Anchor Diameter (inches)	Embedment Depth (inches)	Light Weight Block		Medium Weight Block	
		Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)
3/16	1	220	400	340	730
1/4	1	250	620	500	1500

Stainless Steel Tapcon®

Anchor Diameter (inches)	Embedment Depth (inches)	Hollow Block	
		Tension (lbs.)	Shear (lbs.)
3/16	1-1/4	540	1096
1/4	1-1/4	754	1218

Large Diameter Tapcon® - Zinc & Stainless Steel

Anchor Diameter (inches)	Embedment Depth (inches)	Hollow Block		Grout Filled Block	
		Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)
3/8	1-1/2	916	3176	1592	3900
1/2	2-1/2			5924	6680

** Values shown are average ultimate values and are offered only as a guide and are not guaranteed. A safety factor of 4:1 or 25% is generally accepted as a safe working load. Reference should be made to applicable codes for the specific working ratio. All values are based on close-tolerance holes drilled with carbide lipped drill bits. Designated holding power depends on the quality of the masonry material, depth of embedment, and proper hole size.

Part Numbers

Large Diameter Part Numbers

Blue Climaseal Part #	Stainless Steel Part #	Head Style	Screw Diameter (inches)	Screw Length (inches)	Drill Bit Size (inches)	Socket Size/ Bit Tip	Fixture Hole Size (inches)
TCF316114	TCFS316114	Flat Phillips	3/16	1-1/4	5/32	#2	1/4
TCF316134	TCFS316134	Flat Phillips	3/16	1-3/4	5/32	#2	1/4
TCF316214	TCFS316214	Flat Phillips	3/16	2-1/4	5/32	#2	1/4
TCF316234	TCFS316234	Flat Phillips	3/16	2-3/4	5/32	#2	1/4
TCF316314	TCFS316314	Flat Phillips	3/16	3-1/4	5/32	#2	1/4
TCF316334	TCFS316334	Flat Phillips	3/16	3-3/4	5/32	#2	1/4
TCF3164	—	Flat Phillips	3/16	4	5/32	#2	1/4
TCF14114	TCFS14114	Flat Phillips	1/4	1-1/4	3/16	#3	5/16
TCF14134	TCFS14134	Flat Phillips	1/4	1-3/4	3/16	#3	5/16
TCF14214	TCFS14214	Flat Phillips	1/4	2-1/4	3/16	#3	5/16
TCF14234	TCFS14234	Flat Phillips	1/4	2-3/4	3/16	#3	5/16
TCF14314	TCFS14314	Flat Phillips	1/4	3-1/4	3/16	#3	5/16
TCF14334	TCFS14334	Flat Phillips	1/4	3-3/4	3/16	#3	5/16
TCF144	TCFS144	Flat Phillips	1/4	4	3/16	#3	5/16
TCF145	TCFS145	Flat Phillips	1/4	5	3/16	#3	5/16
TCF146	TCFS146	Flat Phillips	1/4	6	3/16	#3	5/16
TCH316114	—	Hex Washer	3/16	1-1/4	5/32	1/4"	1/4
TCH316134	—	Hex Washer	3/16	1-3/4	5/32	1/4"	1/4
TCH316214	—	Hex Washer	3/16	2-1/4	5/32	1/4"	1/4
TCH316234	—	Hex Washer	3/16	2-3/4	5/32	1/4"	1/4
TCH316314	—	Hex Washer	3/16	3-1/4	5/32	1/4"	1/4
TCH316334	—	Hex Washer	3/16	3-3/4	5/32	1/4"	1/4
TCH3164	—	Hex Washer	3/16	4	5/32	1/4"	1/4
TCH14114	TCHS14114	Hex Washer	1/4	1-1/4	3/16	5/16"	5/16
TCH14134	TCHS14134	Hex Washer	1/4	1-3/4	3/16	5/16"	5/16

TCH14214	TCHS14214	Hex Washer	1/4	2-1/4	3/16	5/16"	5/16
TCH14234	TCHS14234	Hex Washer	1/4	2-3/4	3/16	5/16"	5/16
TCH14314	TCHS14314	Hex Washer	1/4	3-1/4	3/16	5/16"	5/16
TCH14334	TCHS14334	Hex Washer	1/4	3-3/4	3/16	5/16"	5/16
TCH144	TCHS145	Hex Washer	1/4	4	3/16	5/16"	5/16
TCH145	TCHS146	Hex Washer	1/4	5	3/16	5/16"	5/16
TCH146	TCHS146	Hex Washer	1/4	6	3/16	5/16"	5/16
LDT38134	LDTS38134	Hex Washer	3/8	1-3/4	5/16	9/16"	1/2
LDT38212	LDTS38212	Hex Washer	3/8	2-1/2	5/16	9/16"	1/2
LDT383	LDTS383	Hex Washer	3/8	3	5/16	9/16"	1/2
LDT384	LDTS384	Hex Washer	3/8	4	5/16	9/16"	1/2
LDT385	LDTS385	Hex Washer	3/8	5	5/16	9/16"	1/2
LDT12212	LDST12212	Hex Washer	1/2	2-1/2	7/16	3/4"	5/8
LDT123	LDTS123	Hex Washer	1/2	3	7/16	3/4"	5/8
LDT124	LDTS124	Hex Washer	1/2	4	7/16	3/4"	5/8
LDT125	LDTS125	Hex Washer	1/2	5	7/16	3/4"	5/8
LDT126	—	Hex Washer	1/2	6	7/16	3/4"	5/8
LDT583	—	Hex Washer	5/8	3	1/2	15/16"	3/4
LDT584	—	Hex Washer	5/8	4	1/2	15/16"	3/4
LDT585	—	Hex Washer	5/8	5	1/2	15/16"	3/4
LDT586	—	Hex Washer	5/8	6	1/2	15/16"	3/4
LDT34412	—	Hex Washer	3/4	4-1/2	5/8	15/16"	7/8
LDT34512	—	Hex Washer	3/4	5-1/2	5/8	15/16"	7/8
LDT34614	—	Hex Washer	3/4	6-1/4	5/8	15/16"	7/8

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ESR-2202

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DIVISION: 03—CONCRETE
Section: 03151—Concrete Anchoring

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EVALUATION SUBJECT:

TAPCON® WITH ADVANCED THREADFORM TECHNOLOGY ANCHORS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2006 *International Building Code®* (IBC)
- 2006 *International Residential Code®* (IRC)
- 1997 *Uniform Building Code™* (UBC)

Property evaluated:

Structural

2.0 USES

The Tapcon® with Advanced Threadform Technology Anchors are screw anchors used to resist static and wind, tension and shear loads in uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). The anchoring system is an alternative to cast-in-place anchors described in Sections 1911 and 1912 of the IBC and Sections 1923.1 and 1923.2 of the UBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 Tapcon® with Advanced Threadform Technology Anchors:

The Tapcon® with Advanced Threadform Technology Anchors are manufactured from UNS G 10220 (formerly AISI 1022) heat-treaded carbon steel with supplementary heat treatment. They have an alternating high-low thread form on the shank and are available in $^3/_{16}$- and $^1/_4$-inch-diameter (4.8 and 6.4 mm) sizes with various lengths. Tapcon® anchors are available with a slotted hex washer head or phillips flat head, and have a blue Climaseal® coating. Illustrations of anchors are provided in Figure 1.

3.2 Concrete:

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC or UBC, as applicable.

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design tension and shear strengths ($øN_n$ and $øV_n$) must be determined in accordance with ACI 318-05 (ACI 318) Appendix D as modified by the IBC and this report. The anchor design must satisfy the requirements of ACI 318 Sections D.4.1.1 and D.4.1.2. The value of f'_c used in the calculations must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318 Section D.3.5. Strength reduction factors (ø) as given in ACI 318 Section D.4.4 must be used for load combinations calculated in accordance with Section 1605.2 of the IBC, Section 9.2 of ACI 318, or Section 1612.2 of the UBC. Strength reduction factors as given in ACI 318 Section D.4.5 must be used for load combinations set forth in ACI 318 Appendix C or UBC Section 1909.2. Design parameters are provided in Table 1.

4.1.2 Requirements for Static Steel Strength in Tension: The nominal static steel strength of a single anchor in tension must be calculated in accordance with ACI 318 Section D.5.1.2. The resulting N_s values for a single anchor are provided in Table 1 of this report. Strength reduction factors ø corresponding to brittle steel elements as defined in ACI 318 Section D.1.1, and provided in Table 1, must be used.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal static concrete breakout strength for a single anchor or group of anchors in tension (N_{cb} or N_{cbg}) must be calculated in accordance with ACI 318 Section D.5.2, with modifications as described in this section. The nominal concrete breakout strength in tension in regions of concrete where analysis indicates no cracking in service loads, must be calculated in accordance with ACI

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⑬

318 Section D.5.2.6. The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318 Section D.5.2.2 using the values of h_{ef} and k_{uncr} as given in Table 1.

4.1.4 Requirements for Critical Edge Distance: The values for the critical edge distance, c_{ac}, for use with ACI 318 Section D.5.2.7 must be taken from Table 1. In applications where c is less than c_{ac} and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated in accordance with ACI 318 Section 5.2, must be further multiplied by the factor $\psi_{cp,N}$ in accordance with ACI 318 Section D.5.2.7. The values of c_{ac} must be taken from Table 1. For all other cases, $\psi_{cp,N} = 1.0$.

4.1.5 Requirements for Pullout Strength in Tension: The nominal static pullout strength ($N_{p,uncr}$) of a single anchor installed in uncracked concrete is given in Table 1 of this report.

4.1.6 Requirements for Static Steel Strength of Anchor in Shear, V_s: In lieu of the values of V_s as given in ACI 318 Section D.6.1.2(c), the nominal static steel shear values for a single anchor given in Table 1 of this report must be used.

4.1.7 Requirements for Static Concrete Breakout Strength of Anchor in Shear, V_{cb} or V_{cbg}: The nominal static concrete breakout strength shear capacity of a single anchor or group of anchors (V_{cb} or V_{cbg}) must be calculated in accordance with ACI 318 Section D.6.2 based on the values provided in Table 1. The basic concrete breakout strength of a single anchor in cracked concrete, V_b, must be calculated in accordance with ACI 318 Section D.6.2.2 using the values given in Table 1. The value of l_e used in ACI 318 Section D, Eq. (D-24), must be taken as no greater than h_{ef}.

4.1.8 Requirements for Static Concrete Pryout Strength of Anchor in Shear, V_{cp} or V_{cpg}: The nominal static concrete pryout strength shear capacity of a single anchor or group of anchors (V_{cp} or V_{cpg}) must be calculated in accordance with ACI 318 Section D.6.3 based on the values provided in Table 1, and the values of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

4.1.9 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318 Section D.8.3, values of c_a and s_a as given in Table 1 of this report must be used. In lieu of ACI 318 Section D.8.5, minimum concrete thickness h_{min} as given in Table 1 of this report must be used. In lieu of ACI 318 Section D.8.6, the critical edge distance at corners c_{ac} as given in Table 1 of this report must be used.

4.2 Allowable Stress Design:

4.2.1 General: Design values for use with allowable stress design (working stress design) must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \text{ and } V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

where:

$T_{allowable,\ ASD}$	=	Allowable tension load (lbf or kN).
$V_{allowable,\ ASD}$	=	Allowable tension load (lbf or kN).
ϕN_n	=	Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D and IBC Section 1908.1.16 (lbf or kN).
ϕV_n	=	Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D and IBC Section 1908.1.16 (lbf or kN).
α	=	Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength. Limits on edge distance, anchor spacing and member thickness as given in Section 4.1.9 of this report must apply. An illustrative example of allowable stress design values is shown in Table 2.

4.2.2 Interaction: In lieu of ACI 318 Sections D.7.1, D.7.2, and D.7.3, interaction must be calculated as follows:

For shear loads: $V \leq 0.2 \cdot V_{allowable,ASD}$, the full allowable load in tension $T_{allowable,ASD}$ may be taken.

For tension loads: $T \leq 0.2 \cdot T_{allowable,ASD}$, the full allowable load in shear $V_{allowable,ASD}$ may be taken.

For all other cases:

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \leq 1.2$$

4.3 Installation:

The anchors must be installed in accordance with the manufacturer's installation instructions and this report. Anchor location must comply with this report. Embedment, spacing, edge distance, and minimum concrete thickness are shown in Table 1. Holes must be predrilled in concrete with a carbide-tipped drill bit complying with ANSI B212.15-1994, supplied by ITW Buildex. The hole must be drilled to the specified embedment depth plus a minimum of $^1/_4$ inch (6.4 mm). Before anchor installation, dust and other deleterious matter must be removed by use of compressed air, or drilling must continue to an additional depth to accommodate drill fines. The anchors must then be installed through the attachment into the hole, in accordance with ITW Buildex's instructions, to the specified embedment depth using a hammer drill in a rotary-only mode with an ITW Buildex Condrive Tool and drive socket.

4.4 Special Inspection:

Special inspection is required in accordance with Section 1704.13 of the IBC and Section 1701.5.2 of the UBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, anchor spacing, edge distances, concrete thickness, anchor embedment, and adherence to the manufacturer's published installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection." Under the IBC, additional requirements as set forth in Section 1705 or 1706 must be observed.

5.0 CONDITIONS OF USE

The Tapcon® with Advanced Threadform Technology Anchors described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Anchor sizes, dimensions, and installation are as set forth in this report.

5.2 The anchors must be installed in accordance with the manufacturer's published installation instructions and this report in uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). In case of conflict between the manufacturer's installation instructions and this report, this report governs.

5.3 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).

5.4 Strength design values must be established in accordance with Section 4.1 of this report.

5.5 Allowable stress design values must be established in accordance with Section 4.2 of this report.

5.6 Anchor spacing, edge distance, and minimum concrete thickness must comply with Sections 4.1.4 and 4.1.9 and Table 1 of this report.

5.7 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official for approval. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.8 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under these conditions is beyond the scope of this report.

5.9 Anchors used to resist seismic loads must be limited to locations designated as Seismic Design Categories A and B.

5.10 Anchors may be used to resist short-term loading due to wind forces, subject to the conditions of this report.

5.11 Anchors are not permitted to support fire-resistance-rated construction. Where not otherwise prohibited by the code, anchors are permitted for installation in fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind forces only.
- Anchors that support gravity load–bearing structural elements are within a fire-resistance-rated envelope or a fire-resistance-rated membrane, are protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

5.12 Use of anchors must be limited to dry, interior locations.

5.13 Special inspection must be provided in accordance with Section 4.4 of the report.

5.14 Anchors are manufactured under an approved quality control program in Roselle, Illinois, with inspections by CEL Consulting (AA-639).

6.0 EVIDENCE SUBMITTED

Data complying with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated February 2009.

7.0 IDENTIFICATION

The Tapcon® Anchors are identified by packaging labeled with the manufacturer's name (ITW Buildex) and contact information, anchor name, anchor size, evaluation report number (ICC-ES ESR-2202), and the logo of the inspection agency (CEL Consulting). The letters BX and a length identification code letter are stamped on the head of each anchor. See the length identification system in Table 3 of this report.

TABLE 1—ITW BUILDEX TAPCON ANCHOR, DESIGN INFORMATION

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER (inch)	
			$3/16$	$1/4$
Anchor outside diameter	d_o	inches	$3/16$	$1/4$
Effective embedment depth[1]	h_{ef}	inches	1.5	1.5
Nominal embedment depth[1]	h_{nom}	inches	2.0	2.1
Minimum hole depth in concrete[1]	h_{hole}	inches	2.25	2.35
Minimum edge distance	c_a	inches	2	2.5
Minimum anchor spacing	s_a	inches	3	4
Minimum concrete thickness	h_{min}	inches	3.5	3.5
Critical edge distance	c_{ac}	inches	4	4
Category	-	-	1	1
Specified yield strength of anchor steel	f_y	psi	100,000	100,000
Specified tensile strength of anchor steel	f_{ut}	psi	125,000	125,000
Tensile stress area	A_{se}	in^2	0.01474	0.02405
Shear stress area	A_{se}	in^2	0.01474	0.02405
Steel strength in tension	N_s	lbs.	2025	3800
Steel Shear strength	V_s	lbs.	715	1300
Effectiveness factor for concrete breakout	k_{uncr}	-	24	24
Pullout or pull-through resistance	$N_{p,uncr}$	lbs.	590	795
Axial stiffness in service load range	β	in^2	317,000	467,000
Strength reduction factor ϕ for tension, steel failure modes[2,4]			0.65	0.65
Strength reduction factor ϕ for shear, steel failure modes[2,4]			0.60	0.60
Strength reduction factor ϕ for tension, concrete failure modes, Condition B[3,4]			0.65	0.65
Strength reduction factor ϕ for shear, concrete failure modes, Condition B[3,4]			0.70	0.70

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa. For pound-inch units: 1 mm = 0.03937 inch.

[1]See Figure 2 for an illustration of this dimension.
[2]The Tapcon® anchor is a brittle steel element as defined by ACI 318 Section D.1.
[3]Condition B applies in determination of these values where supplementary reinforcement in conformance with ACI 318-05 Section D.4.4 is not provided, or where product pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A as set forth in ACI 318 D.4.4 may be used.
[4]The ϕ factors are for ACI 318 Section D.4.4 when load combinations in IBC Section 1605.1, ACI 318 Section 9.2, and UBC Section 1612.2.1 are used. If the load combinations in ACI 318 Appendix C or UBC Section 1909.2 are used, the value of ϕ must be determined in accordance with ACI 318 Section D.4.5.

TABLE 2—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES FOR TAPCON WITH ADVANCED THREADFORM TECHNOLOGY ANCHOR[1,2,3,4,5,6,7,8]

NOMINAL ANCHOR DIAMETER (inch)	EFFECTIVE EMBEDMENT DEPTH (inches)	ALLOWABLE LOADS (pounds)				
		Tension				Shear
		2,500 psi	3,000 psi	4,000 psi	5,000 psi	2,500 psi
$3/16$	1.5	260	285	330	370	290
$1/4$	1.5	350	385	445	495	525

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa.

[1]Single anchor with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combination 9-2 from ACI 318 Section 9.2 (no seismic loading).
[4]Thirty percent dead load and 70 percent live load, controlling load combination 1.2D + 1.6L.
[5]Calculation of weighted average for $\alpha = 0.3 * 1.2 + 0.7 * 1.6 = 1.48$.
[6]Normal weight concrete
[7]$c_{a1} = c_{a2} > c_{ac}$.
[8]$h \geq h_{min}$.
[9]Condition B in accordance with ACI 318 Section D.4.4 applies.

TABLE 3—LENGTH IDENTIFICATION SYSTEM

LENGTH MARKING ON ANCHOR HEAD		A	B	C	D	E	F	G	H	I	J
Length of anchor (inches)	From	1	$1^1/2$	2	$2^1/2$	3	$3^1/2$	4	$4^1/2$	5	$5^1/2$	6
	Up to, but not including	$1^1/2$	2	$2^1/2$	3	$3^1/2$	4	$4^1/2$	5	$5^1/2$	6	$6^1/2$

For **SI:** 1 inch = 25.4 mm.

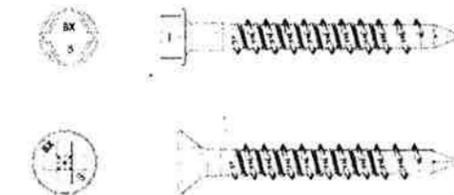**FIGURE 1—ITW BUILDEX TAPCON WITH ADVANCED THREADFORM TECHNOLOGY ANCHORS**
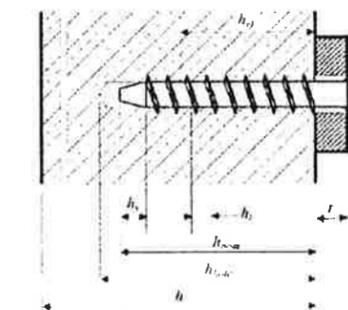
FIGURE 2—EFFECTIVE EMBEDMENT DEPTH OF SCREW ANCHORS

WA34414	WAG34414	WAS34414	3/4	4-1/4	1-3/4	3-1/4	150-175
WA34434	WAG34434	WAS34434	3/4	4-3/4	2-1/4	3-1/4	150-175
WA34512	WAG34512	WAS34512	3/4	5-1/2	3	3-1/4	150-175
WA34614	WAG34614	WAS34614	3/4	6-1/4	3-1/4 - 4	3-1/4	150-175
WA347	WAG347	WAS347	3/4	7	3-1/4 - 4	3-1/4	150-175
WA34812	WAG34812	WAS34812	3/4	8-1/2	3-1/4 - 4	3-1/4	150-175
WA3410	WAG3410	WAS3410	3/4	10	3-1/4 - 4	3-1/4	150-175
WA3412	WAG3412	WAS3412	3/4	12	3-1/4 - 4	3-1/4	150-175
WA786	WAG786	WAS786	7/8	6	3	3-7/8	200-250
WA788	WAG788	WAS788	7/8	8	2-1/4 - 4	3-7/8	200-250
WA7810	WAG7810	WAS7810	7/8	10	2-1/4 - 4	3-7/8	200-250
WA7812	WAG7812	WAS7812	7/8	12	2-1/4 - 4	3-7/8	200-250
WA16	WAG16	WAS16	1	6	3	4-1/2	250-300
WA19	WAG19	WAS19	1	9	4	4-1/2	250-300
WA112	WAG112	WAS112	1	12	4	4-1/2	250-300
WA1149	WAG1149	WAS1149	1-1/4	9	4	5-1/2	400-450
WA11412	WAG11412	WAS11412	1-1/4	12	4	5-1/2	400-450

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ESR-2427

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EVALUATION SUBJECT:

ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHORS, STAINLESS STEEL TRUBOLT+ WEDGE ANCHORS AND CARBON STEEL SAMMYS TRUBOLT+ WEDGE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2009 *International Building Code®* (2009 IBC)
- 2009 *International Residential Code®* (2009 IRC)
- 2006 *International Building Code®* (2006 IBC)
- 2006 *International Residential Code®* (2006 IRC)
- 2003 *International Building Code®* (2003 IBC)
- 2003 *International Residential Code®* (2003 IRC)
- 1997 *Uniform Building Code™* (UBC)

Property evaluated:

Structural

2.0 USES

The carbon steel and stainless steel Trubolt+ Wedge Anchors and $^3/_8$-inch-diameter (9.5 mm) carbon steel Sammys Trubolt+ Wedge Anchor are used to resist static, wind, and seismic tension and shear loads in cracked and uncracked normal-weight and sand-lightweight concrete having a specified compressive strength, f'_c, ranging from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

The carbon steel Trubolt+ Wedge Anchors with diameters of $^3/_8$ inch (9.5 mm), $^1/_2$ inch (12.7 mm) and $^5/_8$-inch (15.9 mm) and the carbon steel Sammys $^3/_8$-inch-diameter (9.5 mm) are used to resist static, wind, and seismic tension and shear loads in cracked and uncracked normal-weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

The Trubolt+ Wedge anchors comply with requirements for anchors installed in hardened concrete as described in Section 1912 of the 2009 and 2006 IBC and Section 1913 of the 2003 IBC. The anchors are alternatives to cast-in-place anchors described in Section 1911 of the 2009 and 2006 IBC, Section 1912 of the 2003 IBC and Sections 1923.1 and 1923.2 of the UBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 RED HEAD Carbon Steel Trubolt+ Wedge Anchor:

The RED HEAD Trubolt+ Wedge Anchor is a torque-controlled, wedge-type mechanical expansion anchor, available in $^3/_8$-inch (9.5 mm), $^1/_2$-inch (12.7 mm), $^5/_8$-inch (15.9 mm) and $^3/_4$-inch (19.1 mm) diameters. The Trubolt+ Wedge Anchor consists of a high-strength threaded anchor body, expansion clip, hex nut and washer. The anchor body is cold-formed from low carbon steel materials conforming to AISI 1015 or AISI 1018 with mechanical properties (yield and ultimate strengths) as described in Tables 3 and 4 of this report. The zinc plating on the anchor body complies with ASTM B 633 SC1, Type III, with a minimum 0.0002-inch (5 µm) thickness. The expansion clip is fabricated from low carbon steel materials conforming to AISI 1020. The standard hexagonal steel nut conforms to ANSI B18.2.2-65 and the washer conforms to ANSI/ASME B18.22.1 1965 (R1981). The Trubolt+ Wedge anchor body consists of a threaded section throughout the majority of its length and a wedge section at the far end. The expansion clip is formed around the anchor, just above the wedge. The expansion clip consists of a split cylindrical ring with undercutting grooves at the bottom

end. During torquing of the anchor, the grooves in the expansion clip are designed to cut into the walls of the concrete hole as the wedge portion of the stud is forced upward against the interior of the clip (U.S. patent nos. 7,744,320 and 7,811,037). The Trubolt+ Wedge anchor is illustrated in Figure 1 of this report.

3.2 RED HEAD Stainless Steel Trubolt+ Wedge Anchor:

The RED HEAD Trubolt+ Wedge Anchor is a torque-controlled, wedge-type mechanical expansion anchor, available in $1/2$-inch (12.7 mm) and $5/8$-inch (15.9 mm) diameters. The Trubolt+ Wedge Anchor consists of a high-strength threaded anchor body, expansion clip, hex nut and washer. The anchor body is cold-formed from AISI Type 316 stainless steel materials with mechanical properties (yield and ultimate strengths) as described in Tables 5 and 6 of this report. The expansion clip is fabricated from Type 316 stainless steel materials. The Type 316 stainless steel hexagonal nut conforms to ANSI B18.2.2-65 and the AISI Type 316 stainless steel washer conforms to ANSI/ASME B18.22.1 1965 (R1981). The Trubolt+ Wedge anchor body consists of a threaded section throughout the majority of its length and a wedge section at the far end. The expansion clip is formed around the anchor, just above the wedge. The expansion clip consists of a split cylindrical ring with undercutting grooves at the bottom end. During torquing of the anchor, the grooves in the expansion clip are designed to cut into the walls of the concrete hole as the wedge portion of the stud is forced upward against the interior of the clip. The Trubolt+ Wedge anchor is illustrated in Figure 1 of this report.

3.3 Sammys Trubolt+ Wedge Anchor:

The Sammys Trubolt+ Wedge Anchor is a torque-controlled, wedge-type mechanical expansion anchor, available in $3/8$-inch (9.5 mm) diameter. The Sammys Trubolt+ Wedge Anchor consists of a high-strength threaded anchor body, expansion clip, coupling nut and washer. The anchor body is cold-formed from low carbon steel materials with the mechanical properties (yield and ultimate strengths) as described in Tables 3 and 4 of this report. The zinc plating on the anchor body complies with ASTM B633 SC1, Type III, with a minimum 0.0002 inch (5 μm) thickness. The expansion clip is fabricated from low carbon steel materials. The coupling nut consists of Grade 2 steel with $3/8$" -16 threads throughout the length of the nut. The washer complies with ANSI/ASME B18.22.1 1965 (R1981). The Sammys Trubolt+ Wedge anchor body consists of a threaded section throughout the majority of its length and a wedge section at the far end. The expansion clip is formed around the anchor, just above the wedge. The expansion clip consists of a split cylindrical ring with undercutting grooves at the bottom end. During torquing of the anchor (using coupling nut), the grooves in the expansion clip are designed to cut into the walls of the concrete hole as the wedge portion of the anchor body is forced upward against the interior of the clip (U.S. patent nos. 7,744,320 and 7,811,037). The Sammys Trubolt+ Wedge anchor is illustrated in Figure 2 of this report.

3.4 Concrete:

Normal-weight and sand-lightweight concrete must comply with Sections 1903 and 1905 of the IBC and UBC, as applicable.

3.5 Steel Deck Panels:

Steel deck panels must comply with ASTM A 653, SS Grade 40 (minimum), and must have a minimum 0.034-inch (0.864 mm) base-metal thickness (No. 20 gage).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors in accordance with the 2009 IBC, 2003 IBC, and the UBC, as well as Section 301.1.3 of the 2009 IRC and 2003 IRC, must be determined in accordance with ACI 318-08 Appendix D and this report. Design strength of anchors in accordance with the 2006 IBC and 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report. Design parameters are based on the 2009 IBC (ACI 318-08) unless noted otherwise in Sections 4.1.1 through 4.1.12 of this report. The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3. Strength reduction factors, ϕ, as given in ACI 318 D.4.4, must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC, Section 9.2 of ACI 318, or Section 1612.2. of the UBC. Strength reduction factors, ϕ, as given in ACI 318 D.4.5, must be used for load combinations calculated in accordance with ACI 318 Appendix C or Section 1909.2 of the UBC. The value of f'_c used in calculations must be limited to 8,000 psi (55.2 MPa), maximum, in accordance with ACI 318 D.3.5. Strength reduction factors, ϕ, corresponding to ductile steel elements may be used except for the carbon steel $3/8$-inch-diameter (9.5 mm) anchors loaded in shear, which have a strength reduction factor corresponding to brittle steel elements.

4.1.2 Requirements for Static Steel Strength in Tension, N_{sa}: The nominal static steel strength of a single anchor in tension, N_{sa}, calculated in accordance with ACI 318, Section D.5.1.2, is given in Tables 3 or 5 of this report.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension, N_{cb}, N_{cbg}: The nominal concrete breakout strength of a single anchor or a group of anchors in tension, N_{cb} or N_{cbg} respectively, must be calculated in accordance with ACI 318 D.5.2, with modifications as described in this section. The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.0 MPa). The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318 D.5.2.2, using the values of h_{ef} and k_{cr} as given in Tables 3 or 5 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318 D.5.2.6 must be calculated with $\psi_{c,N}$ = 1.0 and using the value of k_{uncr} as given in Tables 3 or 5 of this report.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, as shown in Figure 7, calculation of the concrete breakout strength in accordance with ACI 318 D.5.2 is not required.

4.1.4 Requirements for Static Pullout Strength in Tension, N_{pn}: The nominal pullout strength of a single anchor in tension in accordance with ACI 318 D.5.3 in cracked and uncracked concrete, $N_{p,cr}$ or $N_{p,uncr}$, respectively, is given in Tables 3 or 5 of this report. For all design cases, $\psi_{c,P}$ = 1.0. In accordance with ACI 318 D.5.3.2, the nominal pullout strength in tension must be calculated according to Eq-1:

$$N_{p,f'c} = N_{p,cr}\sqrt{\frac{f'_c}{2,500}} \text{ (lb, psi)} \tag{Eq-1}$$

$$N_{p,f'c} = N_{p,cr}\sqrt{\frac{f'_c}{17.2}} \text{ (N, MPa)}$$

In regions where analysis indicates no cracking in accordance with ACI 318 D.5.3.6, the nominal pullout strength in tension must be calculated according to Eq-2:

$$N_{p,f'c} = N_{p,uncr}\sqrt{\frac{f'_c}{2,500}} \text{ (lb, psi)} \tag{Eq-2}$$

$$N_{p,f'c} = N_{p,uncr}\sqrt{\frac{f'_c}{17.2}} \text{ (N, MPa)}$$

Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Tables 3 or 5 of this report, the pullout strength in tension need not be evaluated.

The nominal pullout strength in tension of the anchors installed in the soffit of sand lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 7 of this report, is given in Table 9. In accordance with ACI 318 D.5.3.2, the nominal pullout strength in cracked concrete must be calculated according to Eq-1, whereby the value of $N_{p,deck,cr}$ must be substituted for $N_{p,cr}$ and the value 3,000 psi or 20.7 MPa must be substituted for 2,500 psi or 17.2 MPa. In regions where analysis indicates no cracking in accordance with ACI 318 D.5.3.6, the nominal pullout strength in tension must be calculated according to Eq-2, whereby the value of $N_{p,deck,uncr}$ must be substituted for $N_{p,uncr}$ and the value 3,000 psi or 20.7 MPa must be substituted for 2,500 psi or 17.2 MPa.

4.1.5 Requirements for Static Steel in Shear, V_{sa}: The values of V_{sa} for a single anchor given in Tables 4 or 6 of this report must be used in lieu of the values of V_{sa} derived by calculation according to ACI 318 D.6.1.2.

The shear strength, $V_{sa,deck}$, of anchors installed in the soffit of sand lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 7 of this report, is given in Table 9 of this report.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear, V_{cb} or V_{cbg}: The nominal static concrete breakout strength in shear of a single anchor or a group of anchors, V_{cb} or V_{cbg}, must be calculated in accordance with ACI 318 D.6.2. The basic concrete breakout strength in shear of a single anchor in cracked concrete, V_b, must be calculated in accordance with ACI 318 D.6.2.2 using the value of d_a, given in Table 2 of this report, and the value l_e, given in Tables 4 or 6 of this report, and the value l_e must be taken no greater than h_{ef}. In no cases must l_e exceed $8d_a$.

For anchors installed in the soffit of sand lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 7, calculation of the concrete breakout strength in accordance with ACI 318 D.6.2 is not required.

4.1.7 Requirements for Static Concrete Pryout Strength of Anchor in Shear, V_{cp} or V_{cpg}: The nominal static concrete pryout strength in shear of a single anchor or groups of anchors, V_{cp} or V_{cpg}, must be calculated in accordance with ACI 318 D.6.3, modified by using the value of k_{cp} provided in Tables 4 and 6 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 7 of this report, calculation of the concrete pryout strength in accordance with ACI 318 D.6.3 is not required.

4.1.8 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: Values of c_{min} and s_{min} as given in Table 2 of this report must be used in lieu of ACI 318 D.8.3. Minimum member thicknesses, h_{min}, as given in Tables 2 through 6 of this report, must be used in lieu of ACI 318 D.8.5.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, the anchors must be installed in accordance with Figure 7 of this report and the minimum anchor spacing along the flute must be the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.9 Requirements for Critical Edge Distance and Splitting: In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated according to ACI 318 D.5.2, must be further multiplied by the factor $\psi_{cp,N}$ given by Eq-3:

$$\psi_{cp,N} = c / c_{ac} \tag{Eq-3}$$

Whereby the factor $\psi_{cp,N}$ need not be taken as less than $1.5h_{ef} / c_{ac}$. For all other cases $\psi_{cp,N}$ = 1.0. Values for the critical edge distance c_{ac} must be taken from Tables 3 or 5 of this report.

4.1.10 Requirements for Seismic Design:

4.1.10.1 General: For load combinations including earthquake, the design must be performed according to ACI 318 D.3.3 as modified by Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, as follows:

CODE	ACI 318 D.3.3 SEISMIC REGION	EQUIVALENT CODE DESIGNATION
2003 IBC and 2003 IRC	Moderate or high seismic risk	Seismic Design Categories C, D, E, and F
UBC	Moderate or high seismic risk	Seismic Zones 2B, 3 and 4

The nominal steel strength and the nominal concrete breakout strength for anchors in tension, and the nominal concrete breakout strength and pryout strength for anchors in shear, must be calculated according to ACI 318 D.5 and D.6, respectively, taking into account the corresponding values given in Tables 3 and 4 or Tables 5 and 6 of this report.

The carbon steel $1/2$-inch- (12.7 mm) $5/8$-inch (15.9 mm) and $3/4$-inch-diameter (19.1 mm) anchors, along with the $3/8$-inch-diameter (9.5 mm) anchor loaded in tension, comply with ACI 318 D.1 as ductile steel elements and must be designed in accordance with ACI 318-08 D.3.3.4, D.3.3.5, or D.3.3.6 or ACI 318-05 D.3.3.4 or D.3.3.5. The carbon steel $3/8$-inch-diameter (9.5 mm) anchor loaded in shear must be designed in accordance with ACI 318-08 D.3.3.5 or ACI 318-05 D.3.3.6 as brittle steel elements.

The stainless steel $1/2$-inch- (12.7 mm) and $5/8$-inch (15.9 mm) anchors comply with ACI 318 D.1 as ductile steel elements and must be designed in accordance with ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6 or ACI 318-05 D.3.3.4 or D.3.3.5.

4.1.10.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated according to ACI 318 D.5.1 and D.5.2, as described in Sections 4.1.2 and 4.1.3 of this report and in accordance with ACI 318 D.5.3.2. The value for nominal pullout strength tension for seismic loads, N_{eq} or $N_{p,deck,cr}$, given in Table 3, 5 or 9 of this report, must be used in lieu of N_p. The values of N_{eq} must be adjusted for the concrete strength in accordance with Eq-4:

$$N_{eq,f'c} = N_{eq}\sqrt{\frac{f'_c}{2,500}} \text{ (lb, psi)} \tag{Eq-4}$$

$$N_{eq,f'c} = N_{eq}\sqrt{\frac{f'_c}{17.2}} \text{ (N, MPa)}$$

The value of $N_{p,deck,cr}$ must be calculated according to Eq-4, whereby the value 3,000 psi or 20.7 MPa must be substituted for 2,500 psi or 17.2 MPa.

If no values for N_{eq} are given in Tables 3 or 5, the static design strength values govern. Section 4.1.4 provides additional requirements.

4.1.10.3 Seismic Shear: The nominal concrete breakout strength and pryout strength for anchors in shear must be calculated according to ACI 318 D.6.2 and D.6.3, as described in Sections 4.1.6 and 4.1.7 of this report and in accordance with ACI 318 D.6.1.2. The value for nominal steel strength in shear for seismic loads, V_{eq}, or $V_{sa,deck}$, given in Tables 4, 6 or 9 of this report, must be used in lieu of V_{sa}.

4.1.11 Interaction of Tensile and Shear Forces: For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 D.7.

4.1.12 Requirements for Sand Lightweight Concrete: For ACI 318-08, when anchors are used in sand-lightweight concrete, the modification factor λ for concrete breakout strength must be taken as 0.6. In addition, the pullout strength $N_{p,uncr}$ and N_{eq} must be multiplied by 0.60, as applicable. For ACI 318-05, the values N_b, N_{eq}, $N_{p,uncr}$, and V_b determined in accordance with this report must be multiplied by 0.60, in lieu of ACI 318 D.3.4. For anchors installed in the soffit of sand-lightweight concrete-filled steel deck floor and roof assemblies, this reduction is not required.

4.2 Allowable Stress Design (ASD):

4.2.1 General: For anchors designed using load combinations in accordance with IBC Section 1605.3 or UBC Section 1612.3, allowable loads must be established using Eq-5 and Eq-6:

$$T_{allowable,ASD} = \phi N_n / \alpha \tag{Eq-5}$$

and

$$V_{allowable,ASD} = \phi V_n / \alpha \tag{Eq-6}$$

where

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN).

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN).

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D with amendments in Section 4.1 of this report and Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, as applicable.

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D with amendments in Section 4.1 of this report and Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, as applicable.

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength.

An example of allowable stress design values for illustrative purposes is shown in Table 7 of this report.

4.2.2 Interaction of Tensile and Shear Forces: In lieu of ACI 318 D.7.1, D.7.2 and D.7.3, interaction must be calculated as follows:

For shear loads $V \leq 0.2 \, V_{allowable, ASD}$, the full allowable load in tension, $T_{allowable, ASD}$, may be taken.

For tension loads $T \leq 0.2 \, T_{allowable, ASD}$, the full allowable load in shear, $V_{allowable, ASD}$, may be taken.

For all other cases, Eq-7 applies:

$$T/T_{allowable, ASD} + V/V_{allowable, ASD} \leq 1.2 \tag{Eq-7}$$

4.3 Installation:

Installation parameters are provided in Tables 2 and 8 and Figures 4, 5, and 6 of this report. Anchor locations must comply with this report and the plans and specifications approved by the code official. The Trubolt+ Wedge Anchors must be installed according to ITW's published instructions and this report. Holes must be predrilled in concrete with a compressive strength from 2,500 to 8,500 psi (17.2 to 58.6 MPa) at time of installation, using carbide-tipped masonry drill bits manufactured within the range of the maximum and minimum drill tip dimensions of ANSI Standard B212.15-1994. The nominal drill bit diameter must be equal to that of the anchor size. The minimum drilled hole depth, h_o, must comply with Table 2 of this report. Embedment, spacing, edge distance, and minimum concrete thickness must comply with Table 2. The predrilled holes must be cleaned to remove loose particles, using pressurized air or a vacuum. For the RED HEAD Trubolt+ Wedge Anchor, the hex nut and washer must be assembled on the end of the anchor, leaving the nut flush with the end of the anchor. For the Sammys Trubolt+ Wedge Anchor, the coupling nut and washer must be assembled on the end of the anchor to obtain at least $^1/_2$ inch (12.7 mm) thread engagement on the anchor. The anchors must be hammered into the predrilled hole to the required embedment depth in concrete. Where a fixture is installed, the anchors must be hammered through the fixture into the predrilled hole to the required embedment depth into the concrete. The nut must be tightened against the washer until the specified torque values listed in Table 2 are achieved.

For installation in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, the hole diameter in the steel deck must not exceed the diameter of the hole in the concrete by more than $^1/_8$ inch (3.2 mm). For member thickness, edge distance, spacing restrictions, and installations torque values for installation into the soffit of sand lightweight or normal-weight concrete on steel deck floor and roof assemblies, see Figure 7, Table 8, and Section 4.1.8 of this report.

4.4 Special Inspection:

Special inspection is required in accordance with Section 1704.15 of the 2009 IBC, Section 1704.13 of the 2006 or 2003 IBC and Section 1701.5.2 of the UBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, drill bit type, hole dimensions, hole cleaning procedures, edge distance,

anchor spacing, concrete member thickness, anchor embedment, tightening torque, and adherence to the manufacturer's published installation instructions. The special inspector must be present as often as required in accordance with the statement of special inspection. Under the IBC, additional requirements as set forth in Sections 1705, 1706, and 1707 must be observed, where applicable.

5.0 CONDITIONS OF USE

The Trubolt+ Wedge Anchors described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions.

5.1 The anchors must be installed in accordance with ITW's published instructions and this report. In case of conflicts, this report governs.

5.2 Anchor sizes, dimensions, and installation parameters are as set forth in this report.

5.3 The anchors are limited to installation in cracked and uncracked, normal-weight or sand-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). The anchors may also be installed in cracked and uncracked normal-weight or sand-lightweight concrete over profile steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

5.4 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.0 MPa).

5.5 Strength design values must be established in accordance with Section 4.1 of this report.

5.6 Allowable design values must be established in accordance with Section 4.2 of this report.

5.7 Anchor spacing, edge distance, and minimum member thickness must comply with Tables 2 and 8 and Figures 4, 5, and 6 of this report.

5.8 Prior to installation, calculations and details justifying that the applied loads comply with this report must be submitted to the code official for approval. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of expansion anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.10 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ($f_t > f_r$), subject to the conditions of this report.

5.11 Anchors may be used to resist short-term loading due to wind or seismic forces, subject to the conditions of this report.

5.12 Where not otherwise prohibited in the code, Trubolt+ Wedge Anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support a fire-resistance-rated envelope or a fire-resistance-rated membrane are protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

5.13 Use of the zinc plated, carbon steel anchors is limited to dry, interior locations.

5.14 Special inspections are provided in accordance with Section 4.4 of this report.

5.15 The anchors are manufactured in the USA; under a quality control program with inspections by PFS Corporation (AA-652).

6.0 EVIDENCE SUBMITTED

Data complying with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated February 2010, for use in cracked and uncracked concrete, including optional tests for seismic tension and shear; profile steel deck soffit tests; and quality control documentation.

7.0 IDENTIFICATION

The anchors are identified by their dimensional characteristics and the anchor size, and by a length identification marking stamped on the anchor, as indicated in Table 1 of this report. The anchors have the length identification marking underlined on the anchor head, as illustrated in Figure 3 of this report, and this is visible after installation for verification. Packages are identified with the anchor name, material (carbon or stainless) type and size; the manufacturer's name (ITW Red Head, ITW Brands, or ITW Buildex) and address; the evaluation report number (ICC-ES ESR-2427); and the name of the inspection agency (PFS Corporation).
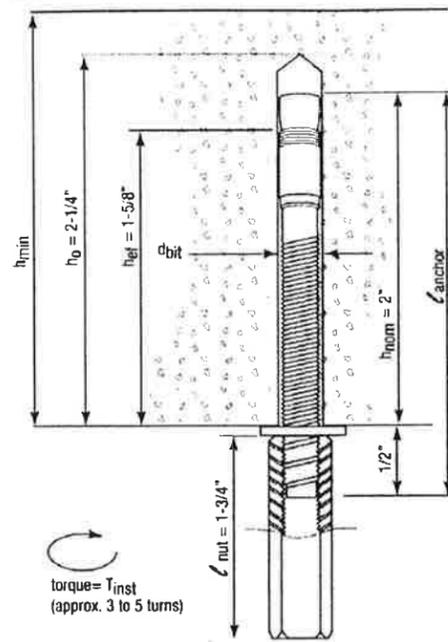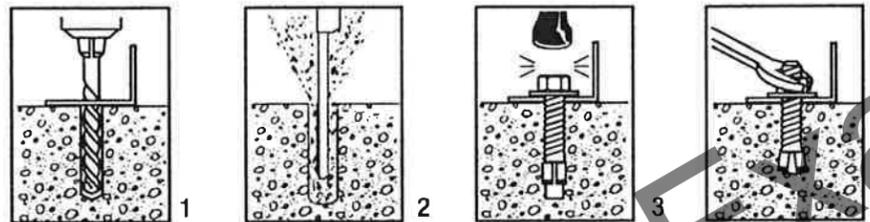
FIGURE 5—SAMMYS TRUBOLT+ WEDGE ANCHOR (INSTALLED), ³/₈ INCH NOMINAL ANCHOR DIAMETER (d₀)

1. Select a carbide drill bit with a diameter equal to the anchor diameter. Drill hole 1/4" deeper than anchor embedment.
2. Clean hole with pressurized air or vacuum to remove any excess dust/debris.
3. Using the washer and nut provided, assemble the anchor, leaving nut one half turn from the end of anchor to protect threads. Drive anchor through fixture to be fastened until washer is flush to surface of fixture.
4. Expand anchor by tightening nut to the specified setting torque (approx 3-5 turns).

FIGURE 6—INSTALLATION INSTRUCTIONS

TABLE 3—ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHOR AND SAMMYS TRUBOLT+ WEDGE ANCHOR TENSION DESIGN INFORMATION[1,2,3,10]

CHARACTERISTIC	SYMBOL[7]	UNITS	NOMINAL ANCHOR DIAMETER (Inch)[8]						
			³/₈		¹/₂		⁵/₈		³/₄
Anchor category	1, 2 or 3	—	1		1		1		1
Minimum effective embedment depth	h_{ef}	In.	1⁵/₈		2	3¹/₄	2³/₄	4¹/₄	3³/₄
Minimum concrete member thickness	h_{min}	In.	4	5	4	6	6	8	6	6¹/₄	7	8
Critical edge distance	c_{ac}	In.	5	3	6	6	7¹/₂	6	7¹/₂	6¹/₂	12	10
Data for Steel Strengths – Tension									
Minimum specified yield strength	f_y	psi	60,000		55,000		55,000		55,000
Minimum specified ultimate strength	f_{uta}	psi	75,000		75,000		75,000		75,000
Effective tensile stress area (neck)	$A_{se,N}\,[A_{se}]^9$	in²	0.056		0.119		0.183		0.266
Steel strength in tension	N_{sa}	lbf	4,200		8,925		13,725		19,950
Strength reduction factor ϕ for tension, steel failure modes[4]	ϕ	—	0.75		0.75		0.75		0.75
Data for Concrete Breakout Strengths in Tension									
Effectiveness factor – uncracked concrete	k_{uncr}	—	24		24		24		24
Effectiveness factor – cracked concrete	k_{cr}	—	17		17		17		17
Modification factor for cracked and uncracked concrete[5]	$\Psi_{c,N}$	—	1.0		1.0		1.0		1.0
Strength reduction factor ϕ for tension, concrete failure modes, Condition B[4]	ϕ	—	0.65		0.65		0.65		0.65
Data for Pullout Strengths									
Pullout strength, uncracked concrete	$N_{p,uncr}$	lbf	See Footnote 8		See Footnote 8	6,540	5,430	8,900	See Footnote 8
Pullout strength, cracked concrete	$N_{p,cr}$	lbf	See Footnote 8		See Footnote 8		See Footnote 8		See Footnote 8
Pullout strength for seismic loads	N_{eq}	lbf	See Footnote 8		See Footnote 8		See Footnote 8	6,715	See Footnote 8
Strength reduction factor ϕ for tension, pullout failure modes, Condition B[4]	ϕ	—	See Footnote 8		0.65		0.65		See Footnote 8
Additional Anchor Data									
Axial stiffness in service load range in uncracked concrete	β_{uncr}	lbf/in	100,000		250,000		250,000		250,000
Axial stiffness in service load range in cracked concrete	β_{cr}	lbf/in	40,000		20,000		20,000		20,000

For SI: 1 inch = 25.4 mm, 1 in² = 645.16 mm², 1 lbf = 4.45 N, 1 psi = 0.006895 MPa, 1 lbf · 10²/in = 17,500 N/m.

[1]The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations, the additional requirements of ACI 318 D.3.3 shall apply.

[2]Installation must comply with the manufacturers printed installation instructions and details.

[3]The ³/₈-, ¹/₂-, ⁵/₈-, and ¾-inch diameter Trubolt + Wedge Anchors are ductile steel elements as defined by ACI 318 D.1.

[4]All values of ϕ apply to the load combinations of IBC Section 1605.2, ACI 318 Section 9.2 or UBC Section 1612.2. If the load combinations of Appendix C or UBC Section 1909.2 are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5. For installations where reinforcement that complies with ACI 318 Appendix D requirements for Condition A is present, the appropriate ϕ factor must be determined in accordance with ACI 318 D.4.4.

[5]For all design cases $\Psi_{c,N}$ = 1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.

[6]The actual diameter for the 3/8-inch diameter anchor is 0.361 inch, for the 5/8-inch diameter anchor is 0.615-inch, and for the ¾-inch diameter anchor is 0.7482-inch.

[7]For 2003 IBC code basis, replace f_{uta} with f_{ut}; N_{sa} with N_s; $\Psi_{c,N}$ with Ψ_3; and N_{eq} with $N_{p,seis}$.

[8]Anchor pullout strength does not control anchor design. Determine steel and concrete capacities only.

[9]The notation in brackets is for the 2006 IBC.

[10]The Sammys version is available in a carbon steel ³/₈-inch-diameter only.

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TABLE 4—ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHOR AND SAMMYS TRUBOLT+ WEDGE ANCHOR SHEAR DESIGN INFORMATION[1,2,3,9]

CHARACTERISTIC	SYMBOL[8]	UNITS	3/8		1/2				5/8		3/4	
Anchor category	1, 2 or 3	—	1		1				1		1	
Minimum effective embedment depth	h_{ef}	In.	1⅝		2		3¼		2¾	4¼	3¾	
Minimum concrete member thickness	h_{min}	In.	4	5	4	6	6	8	6	6¼	7	8
Critical edge distance	c_{ac}	In.	5	3	6	6	7½	6	7½	6½	12	10
Data for Steel Strengths – Shear												
Minimum specified yield strength	f_y	psi	60,000		55,000				55,000		55,000	
Minimum specified ultimate strength	f_{uta}	psi	75,000		75,000				75,000		75,000	
Effective shear stress area (thread)	$A_{se,V}$ $[A_{se}]^9$	in²	0.075		0.142				0.217		0.332	
Steel strength in shear, uncracked or cracked concrete[7]	V_{sa}	lbf	1,830		5,175				8,955		14,970	
Steel strength in shear – seismic loads	V_{eq}	lbf	1,545		5,175				8,955		11,775	
Strength reduction factor φ for shear, steel failure modes[4]	φ	—	0.60		0.65				0.65		0.65	
Data for Concrete Breakout and Concrete Pryout Strengths – Shear												
Coefficient for pryout strength	k_{cp}	—	1.0		1.0		2.0		2.0		2.0	
Load-bearing length of anchor	l_e	in	1⅝		2		3¼		2¾	4¼	3¾	
Strength reduction factor φ for shear, concrete failure modes, Condition B[4]	φ	—	0.70		0.70				0.70		0.70	

For SI: 1 inch = 25.4 mm, 1 in² = 645.16 mm², 1 lbf = 4.45 N, 1 psi = 0.006895 MPa, 1 lbf · 10²/in = 17,500 N/m.

[1]The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations, the additional requirements of ACI 318 D.3.3 shall apply.

[2]Installation must comply with the manufacturers printed installation instructions and details.

[3]The ½, ⅝, and ¾-inch diameter Trubolt + Wedge Anchors are ductile steel elements as defined by ACI 318 D.1. The ⅜ diameter Trubolt + is considered brittle under shear loading.

[4]All values of φ apply to the load combinations of IBC Section 1605.2, ACI 318 Section 9.2 or UBC Section 1612.2. If the load combinations of Appendix C or UBC Section 1909.2 are used, the appropriate value of φ must be determined in accordance with ACI 318 D.4.5. For installations where reinforcement that complies with ACI 318 Appendix D requirements for Condition A is present, the appropriate φ factor must be determined in accordance with ACI 318 D.4.4.

[5]The actual diameter for the ⅜ diameter anchor is 0.361-inch, for the ⅝ diameter anchor is 0.615-inch, and for the ¾ diameter anchor is 0.7482".

[6]For 2003 IBC code basis, replace f_{uta} with f_{ut}; V_{sa} with V_s; $Ψ_{c,V}$ with $Ψ_3$; V_{eq} with $V_{p,seis}$; and l_e with l.

[7]Steel strength in shear values are based on test results per ACI 355.2, Section 9.4 and must be used for design.

[8]The notation in brackets is for the 2006 IBC.

[9]The Sammys version is available in a carbon steel ⅜-inch-diameter only.

TABLE 5—ITW RED HEAD STAINLESS STEEL TRUBOLT+ WEDGE ANCHOR TENSION DESIGN INFORMATION[1,2,3]

CHARACTERISTIC	SYMBOL[7]	UNITS	1/2				5/8	
Anchor category	1, 2 or 3	—	1				1	
Minimum effective embedment depth	h_{ef}	In.	2		3¼		2¾	4¼
Minimum concrete member thickness	h_{min}	In.	4	6	6	8	6	6¼
Critical edge distance	c_{ac}	In.	6	6	7½	6	7½	6½
Data for Steel Strengths – Tension								
Minimum specified yield strength	f_y	psi	65,000				65,000	
Minimum specified ultimate strength	f_{uta}	psi	100,000				100,000	
Effective tensile stress area (neck)	$A_{se,N}$ $[A_{se}]^9$	in²	0.119				0.183	
Steel strength in tension	N_{sa}	lbf	11,900				18,300	
Strength reduction factor φ for tension, steel failure modes[4]	φ	—	0.75				0.75	
Data for Concrete Breakout Strengths in Tension								
Effectiveness factor – uncracked concrete	k_{uncr}	—	24				24	
Effectiveness factor – cracked concrete	k_{cr}	—	17				17	
Modification factor for cracked and uncracked concrete[5]	$Ψ_{c,N}$	—	1.0				1.0	
Strength reduction factor φ for tension, concrete failure modes, Condition B[4]	φ	—	0.65				0.65	
Data for Pullout Strengths								
Pullout strength, uncracked concrete	$N_{p,uncr}$	lbf	See Footnote 8		6,540		5,430	8,900
Pullout strength, cracked concrete	$N_{p,cr}$	lbf	See Footnote 8				See Footnote 8	
Pullout strength for seismic loads	N_{eq}	lbf	2,345		See Footnote 8		See Footnote 8	
Strength reduction factor φ for tension, pullout failure modes, Condition B[4]	φ	—	0.65				0.65	
Additional Anchor Data								
Axial stiffness in service load range in uncracked concrete	$β_{uncr}$	lbf/in	250,000				250,000	
Axial stiffness in service load range in cracked concrete	$β_{cr}$	lbf/in	20,000				20,000	

For SI: 1 inch = 25.4 mm, 1 in² = 645.16 mm², 1 lbf = 4.45 N, 1 psi = 0.006895 MPa, 1 lbf · 10²/in = 17,500 N/m.

[1]The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations, the additional requirements of ACI 318 D.3.3 shall apply.

[2]Installation must comply with the manufacturers printed installation instructions and details.

[3]The ½ and ⅝-inch diameter Trubolt + Wedge Anchors are ductile steel elements as defined by ACI 318 D.1.

[4]All values of φ apply to the load combinations of IBC Section 1605.2, ACI 318 Section 9.2 or UBC Section 1612.2. If the load combinations of Appendix C or UBC Section 1909.2 are used, the appropriate value of φ must be determined in accordance with ACI 318 D.4.5. For installations where reinforcement that complies with ACI 318 Appendix D requirements for Condition A is present, the appropriate φ factor must be determined in accordance with ACI 318 D.4.4.

[5]For all design cases $Ψ_{c,N}$ = 1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.

[6]The actual diameter for the 5/8-inch diameter anchor is 0.615-inch.

[7]For 2003 IBC code basis, replace f_{uta} with f_{ut}; N_{sa} with N_s; $Ψ_{c,N}$ with $Ψ_3$; and N_{eq} with $N_{p,seas}$.

[8]Anchor pullout strength does not control anchor design. Determine steel and concrete capacities only.

[9]The notation in brackets is for the 2006 IBC.

TABLE 6—ITW RED HEAD STAINLESS STEEL TRUBOLT+ WEDGE ANCHOR SHEAR DESIGN INFORMATION[1,2,3]

CHARACTERISTIC	SYMBOL[8]	UNITS	NOMINAL ANCHOR DIAMETER (inch)[5]					
			$^1/_2$				$^5/_8$	
Anchor category	1, 2 or 3	—	1				1	
Minimum effective embedment depth	h_{ef}	In.	2		$3^1/_4$		$2^3/_4$	$4^1/_4$
Minimum concrete member thickness	h_{min}	In.	4	6	6	8	6	$6^1/_4$
Critical edge distance	c_{ac}	In.	6	6	$7^1/_2$	6	$7^1/_2$	$6^1/_2$
Data for Steel Strengths - Shear								
Minimum specified yield strength	f_y	psi	65,000				65,000	
Minimum specified ultimate strength	f_{uta}	psi	100,000				100,000	
Effective shear stress area (thread)	$A_{se,V}\ [A_{se}]^8$	in^2	0.142				0.217	
Steel strength in shear, uncracked or cracked concrete[7]	V_{sa}	lbf	7,265				10,215	
Steel strength in shear - seismic loads	V_{eq}	lbf	5,805				8,105	
Strength reduction factor ϕ for shear, steel failure modes[4]	ϕ	—	0.65				0.65	
Data for Concrete Breakout and Concrete Pryout Strengths - Shear								
Coefficient for pryout strength	k_{cp}	—	1.0		2.0		2.0	
Load-bearing length of anchor	l_e	in	2		$3^1/_4$		$2^3/_4$	$4^1/_4$
Strength reduction factor ϕ for shear, concrete failure modes, Condition B[4]	ϕ	—	0.70				0.70	

For **SI:** 1 inch = 25.4 mm, 1 in^2 = 645.16 mm^2, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa, 1 lbf · 10^2/in = 17,500 N/m.

[1]The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations, the additional requirements of ACI 318 D.3.3 shall apply.

[2]Installation must comply with the manufacturers printed installation instructions and details.

[3]The $^1/_2$- and $^5/_8$-inch diameter Trubolt + Wedge Anchors are ductile steel elements as defined by ACI 318 D.1.

[4]All values of ϕ apply to the load combinations of IBC Section 1605.2, ACI 318 Section 9.2 or UBC Section 1612.2. If the load combinations of Appendix C or UBC Section 1909.2 are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5. For installations where reinforcement that complies with ACI 318 Appendix D requirements for Condition A is present, the appropriate ϕ factor must be determined in accordance with ACI 318 D.4.4.

[5]The actual diameter for the $^5/_8$ diameter anchor is 0.615-inch.

[6]For 2003 IBC code basis, replace f_{uta} with f_{ut}; V_{sa} with V_s; $\Psi_{c,V}$ with Ψ_3; V_{eq} with $V_{p,seis}$; and l_e with l.

[7]Steel strength in shear values are based on test results per ACI 355.2, Section 9.4 and must be used for design.

[8]The ϕ notation in brackets is for the 2006 IBC.

TABLE 7—EXAMPLE ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHOR AND SAMMYS TRUBOLT+ WEDGE ANCHOR ALLOWABLE STRESS DESIGN (ASD) VALUES FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9,10]

ANCHOR NOTATION	ANCHOR EMBEDMENT DEPTH (inches), h_{nom}	EFFECTIVE EMBEDMENT DEPTH (inches), h_{ef}	ALLOWABLE TENSION LOAD (lbs)
$^3/_8$	2	$1^5/_8$	1,090
$^1/_2$	$2^1/_2$	2	1,490
	$3^3/_4$	$3^1/_4$	2,870
$^5/_8$	$3^1/_4$	$2^3/_4$	2,385
	$4^3/_4$	$4^1/_4$	3,910
$^3/_4$	$4^3/_8$	$3^3/_4$	3,825

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

Design assumptions:

[1]Single anchor with static tension load only.

[2]Concrete determined to remain uncracked for the life of the anchorage.

[3]Load combinations are in accordance with ACI 318 Section 9.2 and no seismic loading.

[4]Thirty percent dead load and 70 percent live load, controlling load combination $1.2D + 1.6L$.

[5]Calculation of weighted average for α: $1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48$.

[5]f'_c = 2,500 psi (normal-weight concrete).

[7]$c_{a1} = c_{a2} \geq = c_{ac}$.

[8]$h \geq h_{min}$.

[9]Values are for Condition B where supplementary reinforcement in accordance with ACI 318 D.4.4 is not provided.

[10]The Sammys version is available in a carbon steel $^3/_8$-inch-diameter only.

Illustrative Procedure to Calculate Allowable Stress Design Tension Value:

RED HEAD Carbon Steel Trubolt+ Wedge Anchor $^1/_2$ inch diameter using an effective embedment of 3-1/4 inches, assuming the given conditions in Table 3.

	PROCEDURE		CALCULATION
Step 1	Calculate steel strength of a single anchor in tension per ACI 318 D 5.1.2, Table 3 of this report	ϕN_{sa}	$= \phi\, N_{sa}$ $= 0.75 \cdot 8,925$ **$= 6,694$ lbs steel strength**
Step 2	Calculate concrete breakout strength of a single anchor in tension per ACI 318 D 5.2.2, Table 3 of this report	N_b	$= k_{uncr} \cdot \sqrt{f'_c} \cdot h_{ef}^{1.5}$ $= 24 \cdot \sqrt{2,500} \cdot 3.25^{1.5}$ $= 7,031$ lbs
		ϕN_{cb}	$= \phi\, A_{NC}/A_{NC0}\, \Psi_{ed,N}\, \Psi_{c,N}\, \Psi_{cp,N}\, N_b$ $= 0.65(95/95)/1.0 \cdot 1.0 \cdot 1.0 \cdot 7,031$ $= 0.65 \cdot 7,031$ **$= 4,570$ lbs concrete breakout strength**
Step 3	Calculate pullout strength in tension per ACI 318 D 5.3.2 and Table 3 of this report	ϕN_{pn}	$= \phi\, N_{p,uncr}\, \psi_{c,P}\, (f'_{c,act}/2,500)^\eta$ $= 0.65 \cdot 6,540 \cdot 1.0 \cdot 1.0^{0.5}$ **$= 4,251$ lbs pullout strength**
Step 4	Determine controlling resistance strength in tension per ACI 318 D 4.1.1 and D 4.1.2		**$= 4,251$ lbs controlling resistance**
Step 5	Calculate allowable stress design conversion factor for loading condition per ACI 318 Section 9.2:	α	$= 1.2D + 1.6L$ $= 1.2(0.3) + 1.6(0.7)$ **$= 1.48$**
Step 6	Calculate allowable stress design value per Section 4.2 of this report	$T_{allowable,ASD}$	$= \phi\, N_n / \alpha$ $= 4,251 / 1.48$ **$= 2,870$ lbs allowable stress design**

TABLE 8—ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHOR AND SAMMYS TRUBOLT+ WEDGE ANCHOR INSTALLATION INFORMATION FOR ANCHORS LOCATED IN THE SOFFIT OF CONCRETE FILL ON METAL DECK FLOOR AND ROOF ASSEMBLIES[1,3]

PARAMETER	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER (inch)				
			3/8	1/2		5/8	
Anchor outer diameter	$d_a [d_o]^2$	inches	0.361	0.5		0.615	
Nominal carbide bit diameter	d_{bit}	inches	3/8	1/2		5/8	
Location of Installation	-	-	upper and lower flute	upper and lower flute	lower flute	lower flute	
Minimum effective embedment depth	h_{ef}	inches	1 5/8	2	3 1/4	2 3/4	4 1/4
Anchor embedment depth	h_{nom}	inches	2	2 1/2	3 3/4	3 1/4	4 3/4
Minimum hole depth	h_o	inches	2 1/4	2 3/4	4	3 1/2	5
Minimum overall anchor length	l_{anchor}	inches	2 1/2	3 3/4	4 1/2	4 1/4	6
Installation torque	T_{inst}	ft-lb	30	45		90	
Minimum diameter of hole in fastened part	d_h	inches	1/2	5/8		3/4	

For SI: 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m.

[1]Anchors in the lower and upper flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. In addition, anchors must have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

[2]The notation in brackets is for the 2006 IBC.

[3]The Sammys version is available in a carbon steel 3/8-inch-diameter only.

TABLE 9—ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHOR AND SAMMYS TRUBOLT+ WEDGE ANCHOR DESIGN INFORMATION FOR ANCHORS LOCATED IN THE SOFFIT OF CONCRETE FILL ON METAL DECK FLOOR AND ROOF ASSEMBLIES[1,2]

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER (inch)				
			3/8	1/2		5/8	
Location of Installation	-	-	upper and lower flute	upper and lower flute	lower flute	lower flute	
Minimum effective embedment depth	h_{ef}	inches	1 5/8	2	3 1/4	2 3/4	4 1/4
Characteristic pullout strength, uncracked concrete over metal deck	$N_{p, deck, uncr}[1]$	lbf	2,170	2,515	5,285	3,365	6,005
Characteristic pullout strength, cracked concrete over metal deck	$N_{p, deck, cr}[1]$	lbf	1,650	1,780	4,025	2,405	5,025
Characteristic shear strength, concrete over metal deck	$V_{sa, deck}[1]$	lbf	1,640[3]	2,200	3,790	2,890	6,560
Reduction factor for pullout strength in tension, Condition B	ϕ	-	0.65	0.65		0.65	
Reduction factor for steel strength in shear, Condition B	ϕ	-	0.60	0.65		0.65	

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]Values for $N_{p,deck}$ and $V_{sa,deck}$ apply to sand-lightweight concrete having a minimum concrete compressive strength, f'_c, of 3,000 psi.

[2]All values of ϕ apply to the load combinations of IBC Section 1605.2, ACI 318 Section 9.2 or UBC Section 1612.2. If the load combinations of Appendix C or UBC Section 1909.2 are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5. For installations where reinforcement that complies with ACI 318 Appendix D requirements for Condition A is present, the appropriate ϕ factor must be determined in accordance with ACI 318 D.4.4.

[3]For seismic applications according to Section 4.10.3 of this report multiply the value of $V_{sa,deck}$ by 0.84.
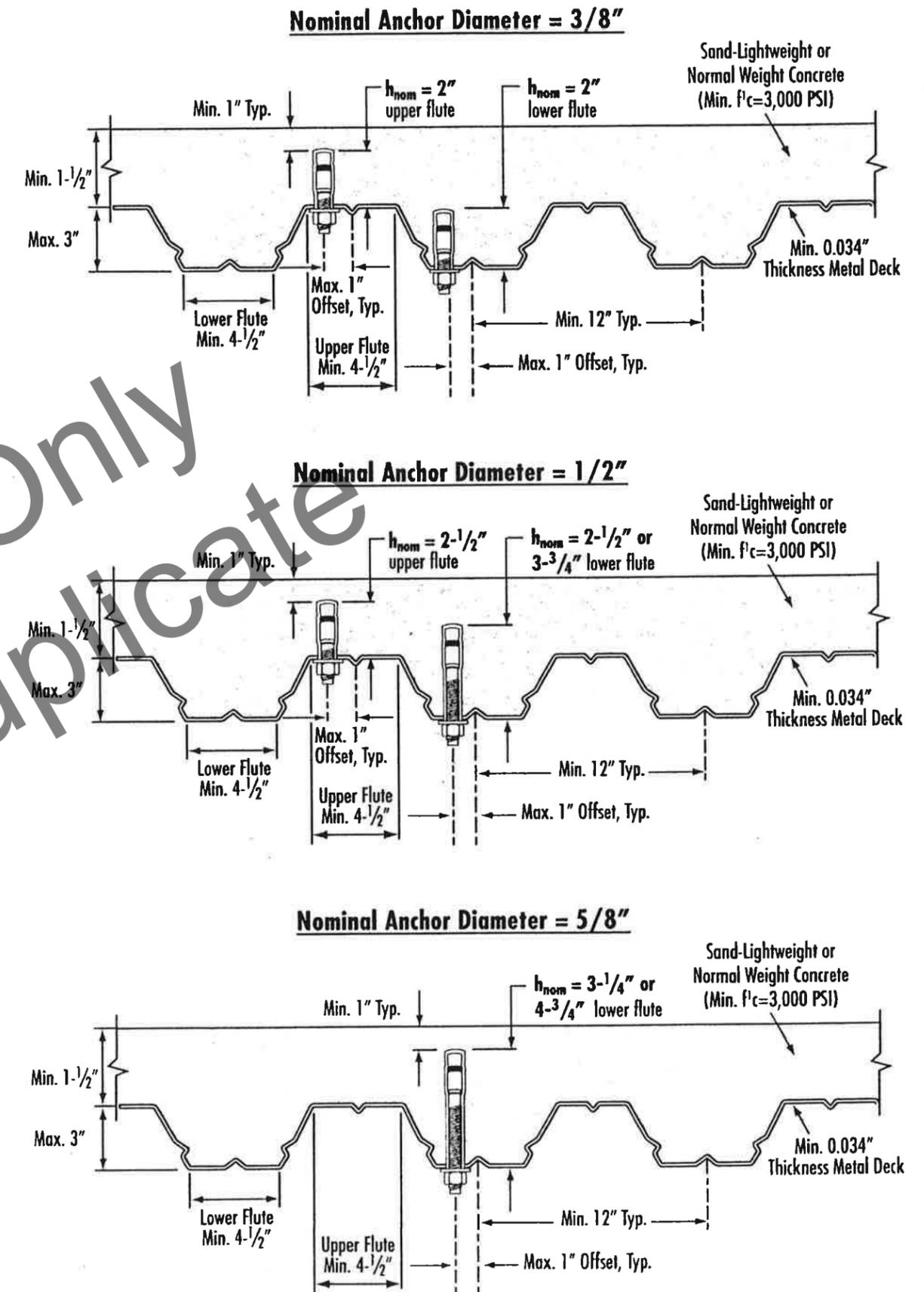
FIGURE 7—ITW RED HEAD CARBON STEEL TRUBOLT+ WEDGE ANCHOR AND SAMMYS TRUBOLT+ WEDGE ANCHOR LOCATED IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (1 Inch = 25.4 mm)