Technical Note

Design of a Steel Stud Backup Wall to a Brick Veneer

Design of a Steel Stud Backup Wall to a Brick Veneer

By: Nabil A. Rahman, Ph.D., P.E.
Paul Lackey, E.I.T.

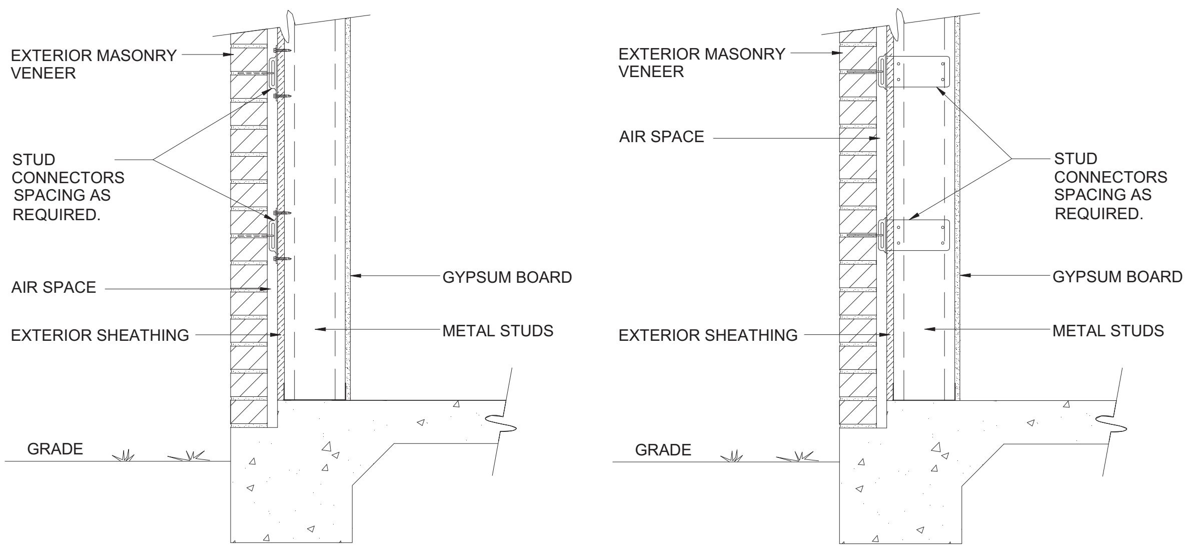
The Steel Network

The Steel Network, Inc.
2012-A T.W. Alexander Drive
P.O. Box 13887
Durham, NC 27709
Phone: (888)474-4876
www.steelnetwork.com

DESIGN OF A STEEL STUD BACKUP WALL TO A BRICK VENEER
33 MIL (50 KSI) VS. 43 MIL (33 KSI)

INTRODUCTION

A steel stud back up wall to a brick veneer functions to resolve wind and earthquake loads into the lateral force resisting diaphragm of the structure. Loads are transferred from the brick veneer to the stud back up wall through ties inserted into the mortar joints of the brick and then attached to either the flange or web of the stud. Depending on the type of brick tie used, wind or seismic loads will be transferred to the stud by either pullout (Figure 1a) or shear (Figure 1b) of the screws attaching the brick tie to the stud.



(a): Tie attached to stud Flange (b): Tie attached to stud web

Figure 1: Methods of attaching the brick tie to the stud

Substantial research has been completed in order to gain a greater understanding of the behavior and design requirements for the system. From this research a tech note by The Brick Industry Association (BIA)[1] and a design guide by the American Iron and Steel Institute (AISI)[2] have been published. Within these references are recommendations for the strength and serviceability requirements of the brick and stud system, including a recommended minimum allowable stud thickness of 0.0451 in. (43 mil). The BIA[1] states "steel studs should have a minimum nominal thickness of 0.043 in. to provide sufficient thickness to engage the threads of the screw." Although not specifically stated within the given references, industry standard maintains the steel yield strength of 43 mil studs as 33 ksi.

The purpose of this technical note is to demonstrate that the use of a stud with a steel thickness of 0.0346 in. (33 mil) and yield strength of 50 ksi meets or exceeds the connection strength provided by the recommended minimum and can be used efficiently as a stud backup to a brick veneer.

PULL-OUT STRENGTH

For a load transfer from brick tie to stud flange through tension of the screw, the disparity in load capacity of the brick tie attachment to the stud between the two stud types is dependant upon the pullout capacity of the screw connection.

Design for Pull-Out, Per AISI NAS-2001[3], Section E4.4.1

Assuming thickness of tie = 0.0713 in. (68 mil)

Stud Thickness = 0.0346 in. **(33 mil), 50 ksi**	Stud Thickness = 0.0451 **(43 mil), 33 ksi**
$t_c = 0.0346$ in. $F_{u2} = 65$ ksi d = 0.190 in. $P_{not} = 0.85 t_c d F_{u2}$ $= 0.85(0.0346)(0.190)(65)$ $P_{not} = 0.36$ kips	$t_c = 0.0451$ in. $F_{u2} = 45$ ksi d = 0.190 in. $P_{not} = 0.85 t_c d F_{u2}$ $= 0.85(0.0451)(0.190)(45)$ $P_{not} = 0.33$ kips

SHEAR STRENGTH

For a load transfer from brick tie to stud web through shear of the screw, the disparity in load capacity of the brick tie attachment to the stud between the two stud types is dependant upon the tilting and bearing of the screw connection.

Design for Tilting and Bearing, Per AISI NAS-2001[3], Section E4.3.1

Assuming thickness of tie = 0.0566 in. (54 mil)

Stud Thickness = 0.0346 in. **(33 mil), 50 ksi**	Stud Thickness = 0.0451 **(43 mil), 33 ksi**
$t_1 = 0.0566$ in. $t_2 = 0.0346$ in. $F_{u1} = 65$ ksi $F_{u2} = 65$ ksi d = 0.190 in. $\frac{t_2}{t_1} = \frac{0.0346}{0.0566} = 0.611 < 1.0$ P_{ns} (shear strength) is lesser of, $4.2(t_2^3 d)^{\frac{1}{2}} F_{u2} = 4.2(0.0346^3 0.190)^{\frac{1}{2}} 65 = 0.77$ $2.7 t_1 d F_{u1} = 2.7(0.0566)(0.190)(65) = 1.89$ $2.7 t_2 d F_{u2} = 2.7(0.0346)(0.190)(65) = 1.15$ $P_{ns} = 0.77$ kips	$t_1 = 0.0566$ in. $t_2 = 0.0451$ in. $F_{u1} = 65$ ksi $F_{u2} = 45$ ksi d = 0.190 in. $\frac{t_2}{t_1} = \frac{0.0451}{0.0566} = 0.797 < 1.0$ P_{ns} (shear strength) is lesser of, $4.2(t_2^3 d)^{\frac{1}{2}} F_{u2} = 4.2(0.0451^3 0.190)^{\frac{1}{2}} 45 = 0.79$ $2.7 t_1 d F_{u1} = 2.7(0.0566)(0.190)(65) = 1.89$ $2.7 t_2 d F_{u2} = 2.7(0.0451)(0.190)(45) = 1.04$ $P_{ns} = 0.79$ kips

CONCLUSION

Previous recommendations by BIA and AISI for steel studs backing a brick veneer depict a minimum 43 mil stud thickness. The industry standard for steel yield strength of a 43 mil stud is 33 ksi. This technical note has effectively shown the strength of the connection between the brick tie and the stud of a 33 mil stud utilizing a steel of 50 ksi yield strength essentially meets or exceeds that of a 43 mil stud utilizing a steel of 33 ksi yield strength, and can be effectively used within this system. Additional design issues to be considered by the design professional in the design of a steel stud backing a brick veneer independent of stud thickness include:

- **Web Crippling Strength of the Stud**: Crippling of the stud web needs to be checked as the reaction is transferred to the track by bearing against the track leg. See AISI NAS-2001[3], Section C3.4. For a flange mounted brick tie only, web crippling should also be considered at the location of the tie.
- **Deflection of the Stud**: Both BIA[1] and AISI[2] recommend restricting out of plane deflection of steel studs to L/600. Per IBC Table 1604.3, footnote f. "the wind load is permitted to be taken as 0.7 times the "component and cladding" loads for the purpose of determining deflection limits"
- **Strength of the Stud**: Per AISI[2], Section 3.1.1, the stud should be designed for the full wind and earthquake load ignoring any structural contribution from the brick veneer
- **Rotation of the Stud**: A bridging system or sheathing system should be designed within the wall plane in order to resist the twisting of the steel stud subjected to the lateral load
- **Local Flange Rotation**: For a flange mounted brick tie only, the stud flange attached to the tie may be subjected to rotation locally. Rotation of the flange will increase the flexibility of the brick.

REFERENCES

[1] The Brick Industry Association, "Brick Veneer/Steel Stud Walls", Technical Notes on Brick Construction 28B, December 2005, Reston, Virginia

[2] American Iron and Steel Institute, "Steel Stud Brick Veneer Design Guide", AISI Design Guide CF03-01, November 2003, Washington D.C.

[3] American Iron and Steel Institute, "North American Specification for the Design of Cold-Formed Steel Structural Members", AISI Standard, 2001 Edition, Washington, DC