



# CORDLESS STUD FUSION (CSF)

Visual Examination Catalog  
2023



## HILTI F-BT VISUAL EXAMINATION CATALOG

This document provides guidance for installing and inspecting Hilti F-BT studs with Hilti's Cordless Stud Fusion technology. This process is referred to as visual examination and assessment and is split into two parts.

First, the examination of the surface preparation (Table 2 and Table 3) prior to welding, and second, the examination for the F-BT stud welding after installation (Table 4 and Table 5).

This catalog is provided to help assess the visual appearance of the preparations and welds as acceptable or in need of corrective action and/or additional quality checks.

The criteria for the appearance of the stud weld are complementary to the requirements of EN ISO 14555:2017 Table A.5 and AWS D1.6 Clause 9.7. Using these standards as a baseline, this document addresses the specifics of the Hilti F-BT welded studs.

The examination for surface preparation is unique to the appearance of preparations completed using the Hilti FX 3-ST surface tools.

Table 1 explains how to read the schematic sketches used in this catalog.

**Table 1: Schematics explanation**

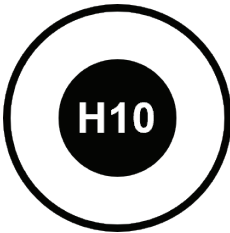
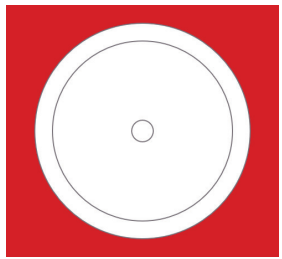
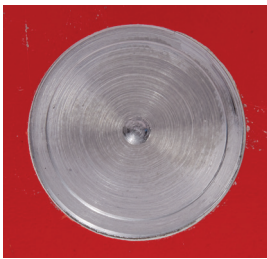
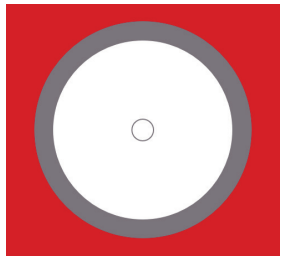
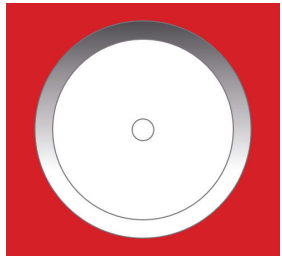
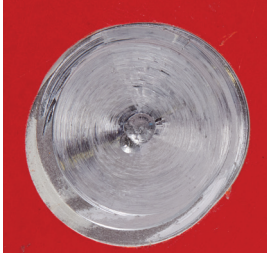
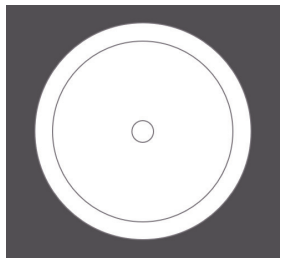
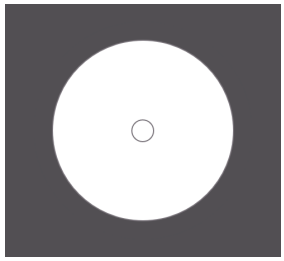
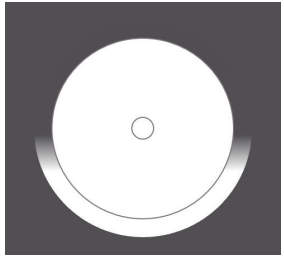
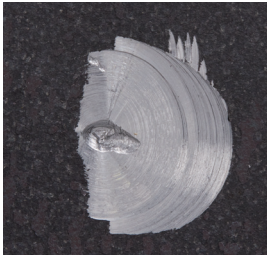
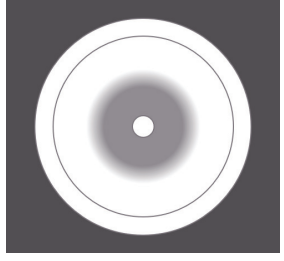
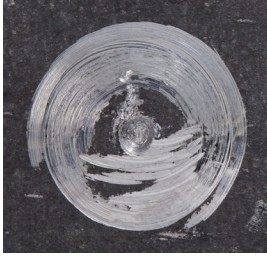
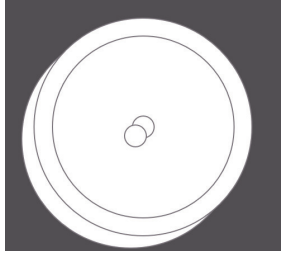
| Schematic                                                                           | Explanation                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Surface preparation examination</b>                                              |                                                                                                                                                                                                                                                                                                         |
|   | <p>Top-down view of surface preparation on coated steel. The coating color is red in this example.</p> <p>An outer ring is shown. The schematic shows a "shiny ring" on the outside.</p> <p>The small circle in the center represents the indentation formed by the center tip of the surface tool.</p> |
| <b>Welded stud examination</b>                                                      |                                                                                                                                                                                                                                                                                                         |
|  | <p>Top-down view of an F-BT welded to the parent material prepared with FX 3-ST d20 surface tool.</p>                                                                                                                                                                                                   |
|  | <p>Top-down view of an F-BT welded to the parent material prepared with FX 3-ST d14 surface tool.</p>                                                                                                                                                                                                   |

Table 2: Surface preparation of coated parent material with surface tool FX 3-ST d20

| No. | Schematics                                                                          | Example images                                                                      | Assessment                                                                           | Recommended corrective action                                                                                                                                                                            |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Blank and shiny ring                                                                |                                                                                     | ACCEPTABLE                                                                           | None                                                                                                                                                                                                     |
|     |    |    |                                                                                      |                                                                                                                                                                                                          |
| 2   | Residuals on the outer ring                                                         |                                                                                     | ISSUE: Residuals on the outer ring, which will be a dull color than the center ring. | Continue the preparation process until the stop shoulder (outer ring) is clean 360° around.<br><br>*Replace the surfacing bit with a new part if worn.                                                   |
|     |    |    |                                                                                      |                                                                                                                                                                                                          |
| 3   | Inclined preparation surface                                                        |                                                                                     | ISSUE: One-sided residuals and inclined preparations.                                | Continue the preparation process and tilt the drilling machine slightly to the side, where residuals are found to remove them and provide an even surface for stud installation.                         |
|     |   |   |                                                                                      |                                                                                                                                                                                                          |
| 4   | Uneven preparation                                                                  |                                                                                     | ISSUE: Residuals on the surface.                                                     | Hold and press the tool straight to the surface when preparing the surface.<br><br>Avoid wobbling of the surface tool.                                                                                   |
|     |  |  |                                                                                      |                                                                                                                                                                                                          |
| 5   | Unsymmetrical or doubled preparation                                                |                                                                                     | ISSUE: An unsymmetrical preparation showing a double circle.                         | Do not use unsymmetrical preparations for welding.<br><br>Create a preparation at a new location.<br><br>For new preparations, hold and press the tool straight and firm during the preparation process. |
|     |  |  |                                                                                      |                                                                                                                                                                                                          |

\*User should always replace the surfacing bit with a new part for all preparations if worn.

Table 3: Surface preparation of uncoated parent material with surface tool FX 3-ST d14

| No. | Schematics                                                                          | Example images                                                                      | Assessment                                            | Recommended corrective action                                                                                                                                                                                                                                                                |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Blank and shiny ring                                                                |                                                                                     | ACCEPTABLE                                            | None                                                                                                                                                                                                                                                                                         |
|     |    |    |                                                       |                                                                                                                                                                                                                                                                                              |
| 2   | Residuals on the outer ring                                                         |                                                                                     | ISSUE: Residuals on ring.                             | Continue the preparation process until the stop shoulder (outer ring) is clean 360° around.<br><br>*Replace the surfacing bit with a new part if worn.                                                                                                                                       |
|     |    |    |                                                       |                                                                                                                                                                                                                                                                                              |
| 3   | Inclined preparation surface                                                        |                                                                                     | ISSUE: One-sided residuals and inclined preparations. | Ensure the tip of the surfacing bit is placed back into the centering hole as to not create multiple voids. Continue the preparation process and tilt the drilling machine slightly to the side, where residuals are found to remove them and provide an even surface for stud installation. |
|     |   |   |                                                       |                                                                                                                                                                                                                                                                                              |
| 4   | Uneven preparation                                                                  |                                                                                     | ISSUE: Residuals on the surface.                      | Hold and press the tool straight to the surface when preparing the surface.<br><br>Avoid wobbling of the surface tool.                                                                                                                                                                       |
|     |  |  |                                                       |                                                                                                                                                                                                                                                                                              |
| 5   | Unsymmetrical or doubled preparation                                                |                                                                                     | ISSUE: An unsymmetrical or doubled preparation.       | Do not use unsymmetrical preparations for welding.<br><br>Create a preparation at a new location.<br><br>For new preparations, hold and press the tool straight and firm during the preparation process.                                                                                     |
|     |  |  |                                                       |                                                                                                                                                                                                                                                                                              |

\*User should always replace the surfacing bit with a new part for all preparations if worn.

Table 4: Visual examination for F-BT studs welded on coated steel (surface tool FX 3-ST d20)

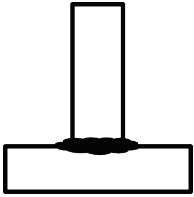
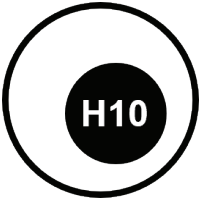
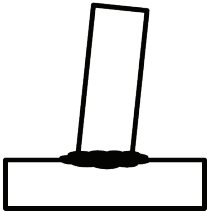
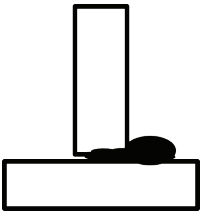
| No. | Schematics                                                                          | Example images                                                                      | Assessment                                                 | Recommended corrective action                                                                                                                                                     | Complementary to                                                                     |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 1   | Regular and complete collar                                                         |                                                                                     | ACCEPTABLE                                                 | None                                                                                                                                                                              | Table A.5, No. 4 of EN ISO 14555:2017                                                |
|     |    |    |                                                            |                                                                                                                                                                                   |                                                                                      |
| 2   | Eccentric stud                                                                      |                                                                                     | ISSUE: Studs welded eccentric to the circular preparation. | <b>Remove and reinstall stud.</b><br>Center the tip of the stud in the middle of the surface preparation.<br>Hold the hand tool FX 3-HT centered, perpendicular, and calm.        | Table A.5, No. 4 of EN ISO 14555:2017                                                |
|     |    |    |                                                            |                                                                                                                                                                                   |                                                                                      |
| 3   | Inclined stud >2°                                                                   |                                                                                     | ISSUE: Inclined studs >2°.                                 | <b>Remove and reinstall stud.</b><br>Hold the hand tool perpendicular and firm during welding.<br>Assure that the surface preparation is parallel to the parent material surface. | Table A.5, No. 4 of EN ISO 14555:2017                                                |
|     |  |   |                                                            |                                                                                                                                                                                   |                                                                                      |
| 4   | One-sided connection, weld drop protruding                                          |                                                                                     | ISSUE: One-sided weld connection.                          | <b>Test or remove the welded stud.</b><br>Comply with the surface preparation requirements in Table 2.<br>Comply with ground clamp, stud, and edge spacing requirements.          | Table A.5, No. 4 of EN ISO 14555:2017<br>and<br>Clause 9.7.1 of AWS D1.6/D1.6M: 2017 |
|     |  |  |                                                            |                                                                                                                                                                                   |                                                                                      |

Table 4: Visual examination for F-BT studs welded on coated steel (surface tool FX 3-ST d20) (continued)

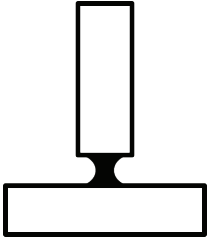
| No. | Schematics                                                                          | Example images                                                                      | Assessment                                                              | Recommended corrective action                                                                                                                                                                                 | Complementary to                                                                           |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 5   | Soot around the weld                                                                |                                                                                     | <b>ISSUE:</b> Studs with soot around the weld.                          | <b>Test or remove the welded stud.</b><br>Comply with the surface preparation requirements in Table 2.<br>Ensure that the surface preparation and stud are free of contamination.                             | Table A.5, No. 3 and 4 of EN ISO 14555:2017                                                |
|     |    |    |                                                                         |                                                                                                                                                                                                               |                                                                                            |
| 6   | Splatter or sparks                                                                  |                                                                                     | <b>ISSUE:</b> Studs with splatter or sparks around the weld.            | <b>Test or remove the welded stud.</b><br>Comply with the surface preparation requirements in Table 2.<br>Ensure that the surface preparation and stud are free of contamination.                             | Table A.5, No. 3 and 5 of EN ISO 14555:2017<br>and<br>Clause 9.7.1 of AWS D1.6/D1.6M: 2017 |
|     |    |    |                                                                         |                                                                                                                                                                                                               |                                                                                            |
| 7   | Weld diameter reduced, unusual standoff                                             |                                                                                     | <b>ISSUE:</b> Studs with a reduced diameter or unusual, high stand-off. | <b>Remove and reinstall stud.</b><br>Check Weld Code (H-Code) setting.<br>Comply with surface preparation requirements in Table 2.<br>Ensure that the surface preparation and stud are free of contamination. | Table A.5, No. 2 of EN ISO 14555:2017<br>and<br>Clause 9.7.1 of AWS D1.6/D1.6M: 2017       |
|     |   |   |                                                                         |                                                                                                                                                                                                               |                                                                                            |
| 8   | F-Code displayed on the tool                                                        |                                                                                     | <b>ISSUE:</b> Studs with F-Code displayed after the weld.               | <b>Follow the actions required in Table 6.</b><br>Corrective actions depending on F-Code are listed in Table 6.                                                                                               |                                                                                            |
|     |  |  |                                                                         |                                                                                                                                                                                                               |                                                                                            |

Table 5: Visual examination for F-BT studs welded on uncoated steel (surface tool FX 3-ST d14)

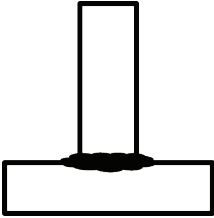
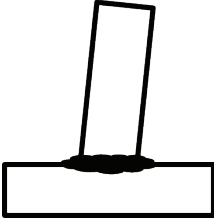
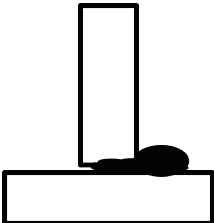
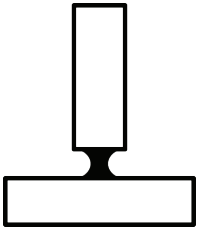
| No. | Schematics                                                                          | Example images                                                                      | Assessment                                                 | Recommended corrective action                                                                                                                                                     | Complementary to                                                                     |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 1   | Regular complete collar around the weld pin                                         |                                                                                     | ACCEPTABLE                                                 | None                                                                                                                                                                              | Table A.5, No. 4 of EN ISO 14555:2017                                                |
|     |    |    |                                                            |                                                                                                                                                                                   |                                                                                      |
| 2   | Eccentric stud                                                                      |                                                                                     | ISSUE: Studs welded eccentric to the circular preparation. | <b>Remove and reinstall stud.</b><br>Center the tip of the stud in the middle of the surface preparation.<br>Hold the hand tool FX 3-HT centered, perpendicular, and calm.        | Table A.5, No. 4 of EN ISO 14555:2017                                                |
|     |    |    |                                                            |                                                                                                                                                                                   |                                                                                      |
| 3   | Inclined stud >2°                                                                   |                                                                                     | ISSUE: Inclined studs >2°.                                 | <b>Remove and reinstall stud.</b><br>Hold the hand tool perpendicular and firm during welding.<br>Assure that the surface preparation is parallel to the parent material surface. | Table A.5, No. 4 of EN ISO 14555:2017                                                |
|     |  |  |                                                            |                                                                                                                                                                                   |                                                                                      |
| 4   | One-sided connection, weld drop protruding                                          |                                                                                     | ISSUE: One-sided weld connection.                          | <b>Test or remove the welded stud.</b><br>Comply with the surface preparation requirements in Table 3.<br>Comply with ground clamp, stud, and edge spacing requirements.          | Table A.5, No. 4 of EN ISO 14555:2017<br>and<br>Clause 9.7.1 of AWS D1.6/D1.6M: 2017 |
|     |  |  |                                                            |                                                                                                                                                                                   |                                                                                      |

Table 5: Visual examination for F-BT studs welded on uncoated steel (surface tool FX 3-ST d14) (continued)

| No. | Schematics                                                                          | Example images                                                                      | Assessment                                                              | Recommended corrective action                                                                                                                                                                                | Complementary to                                                                           |
|-----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 5   | Soot around the weld                                                                |                                                                                     | <b>ISSUE:</b> Studs with soot around the weld.                          | <b>Test or remove the welded stud.</b><br>Comply with the surface preparation requirements in Table 3.<br>Ensure that the surface preparation and stud are free of contamination.                            | Table A.5, No. 3 and 4 of EN ISO 14555:2017                                                |
|     |    |    |                                                                         |                                                                                                                                                                                                              |                                                                                            |
| 6   | Splatter or sparks                                                                  |                                                                                     | <b>ISSUE:</b> Studs with splatter or sparks around the weld.            | <b>Test or remove the welded stud.</b><br>Comply with the surface preparation requirements in Table 3.<br>Ensure that the surface preparation and stud are free of contamination.                            | Table A.5, No. 3 and 5 of EN ISO 14555:2017<br>and<br>Clause 9.7.1 of AWS D1.6/D1.6M: 2017 |
|     |    |    |                                                                         |                                                                                                                                                                                                              |                                                                                            |
| 7   | Weld diameter reduced, unusual standoff                                             |                                                                                     | <b>ISSUE:</b> Studs with a reduced diameter or unusual, high stand-off. | <b>Remove and reinstall stud.</b><br>Check the Weld Code setting.<br>Comply with the surface preparation requirements in Table 3.<br>Ensure that the surface preparation and stud are free of contamination. | Table A.5, No. 2 of EN ISO 14555:2017<br>and<br>Clause 9.7.1 of AWS D1.6/D1.6M: 2017       |
|     |  |   |                                                                         |                                                                                                                                                                                                              |                                                                                            |
| 8   | F-Code displayed on the tool                                                        |                                                                                     | <b>ISSUE:</b> Studs with F-Code displayed after the weld.               | <b>Follow the actions required in Table 6.</b><br>Corrective actions depending on F-Code listed in Table 6.                                                                                                  |                                                                                            |
|     |  |  |                                                                         |                                                                                                                                                                                                              |                                                                                            |

**Table 6: F-Code list, failure case requiring removal or inspection of stud**

| F-Code             | Failure case                     | Required action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
|--------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------------------------|----|----------|----|----------|----|-----------|-----|-----------|
| F06                | Hand tool inner mechanics sticky | <b>Either:</b><br><br>Test the installed stud to a tensile-proof load with the Hilti HAT 28 FX. Standard tensile proof loads are provided in the table below, which are based on the weld code (H-code) embossed on the stud head, assuming standard base material specification and thickness provided in the Hilti CSF Technical Manual. Factors such as base material specification, lower material thickness, and application needs may affect the required proof load. To ensure all variables are accounted for, proof loads should be verified with the Engineer of Record (EoR) prior to testing.<br><table><tr><th>Weld code (H-Code)</th><th>Tensile proof load in kN (lbf)</th></tr><tr><td>H1</td><td>6 (1350)</td></tr><tr><td>H2</td><td>9 (2025)</td></tr><tr><td>H3</td><td>17 (3820)</td></tr><tr><td>H10</td><td>22 (4950)</td></tr></table><br><b>Or:</b><br>Remove and reinstall the stud directly without testing. | Weld code (H-Code) | Tensile proof load in kN (lbf) | H1 | 6 (1350) | H2 | 9 (2025) | H3 | 17 (3820) | H10 | 22 (4950) |
| Weld code (H-Code) | Tensile proof load in kN (lbf)   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| H1                 | 6 (1350)                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| H2                 | 9 (2025)                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| H3                 | 17 (3820)                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| H10                | 22 (4950)                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| F07                | Electrical connection bad        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| F10                | Stud embedment is not proper     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| F14                | Operator interrupted process     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| F16                | Spot contaminated                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                |    |          |    |          |    |           |     |           |
| F17                | Process aborted                  | Remove and reinstall the stud                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                    |                                |    |          |    |          |    |           |     |           |

- For corrective actions to avoid the repeated occurrence of F-Codes, see Sticker inside of the FX 3-HT Kit box.
- For troubleshooting of F-Codes not listed here, see Sticker inside the FX 3-HT Kit box.

The data contained herein was current as of the date of publication. Updates and changes may be made based on later testing. If verification is needed that the data is still current, please contact the Hilti Technical Support Specialists at 1-877-749-6337. All published load values herein represent the results of testing by Hilti or test organizations. Because of variations in materials, on-site testing may be necessary to determine performance at any specific site.



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