

2024 Student Steel Bridge Competition

9.4 CONNECTION SAFETY EXAMPLES

This document identifies examples of prohibited and allowed connections in order to provide assistance in understanding the Connection Safety Rules in Sub-Section 9.4 of the [2024 Student Steel Bridge Competition \(SSBC\) Rules](#). The examples and connections shown do not represent the entirety of possible allowed or prohibited connections for the 2023 SSBC. Note that there are no restrictions placed on connections during construction provided that safe construction practices are maintained. The connection requirements in Sub-Section 9.4 will only be checked during the inspection period after termination of timed construction.

9.4.1 All locations where one member touches another member require a connection. Multiple members may be connected at the same location. If two or more members touch at multiple locations where the points of contact are not associated with a continuous surface or occur at different locations along the member, then a connection shall be required at each location.

9.4.2 Each connection shall contain at least one and at most two faying surfaces associated with each member being connected.

9.4.2.1 Faying surfaces are the only locations where members are in contact with each other.

9.4.2.2 Faying surfaces that are a gradual curves shall not have inflection points. Contact surfaces on either side of a corner or bend, as opposed to a gradual curve, shall be treated as separate faying surfaces.

9.4.2.3 Every faying surface shall be penetrated by at least one loose bolt secured by a loose nut such that the members cannot be separated without first unscrewing and removing the loose bolt(s) that connects them. A violation where a nut has not been installed on a bolt must be corrected during the 5 minute correction period. A loose bolt may connect more than two members.

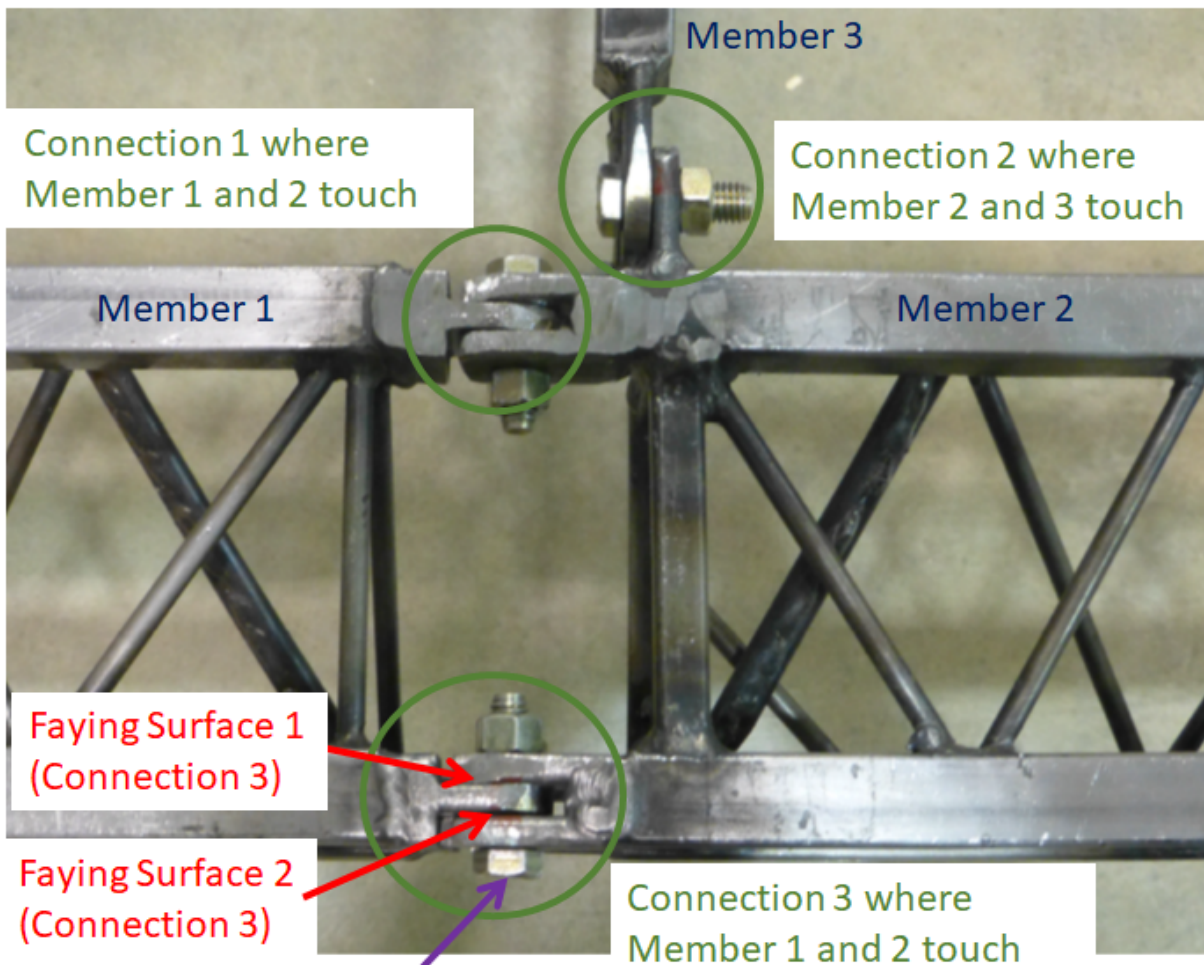
9.4.2.4 Minor, unintentional gaps between the faying surfaces of members due to member fabrication imperfections shall be allowed and treated as continuous faying surfaces provided the resulting waves or protrusions in the faying surfaces are not large enough to resist moment without the presence of a bolt.

9.4.2.5 Cam locks, dovetails, tube-in-tube/sleeved and other mechanical/interlocking connections that are designed to resist movement without the presence of a bolt are prohibited regardless of whether a bolt penetrates the faying surfaces.

9.4.3 Each individual hole in a member for a loose bolt shall be completely surrounded by the member. Furthermore, such holes in the outer plies of a connection shall be small enough that the nut or bolt head cannot pass through.

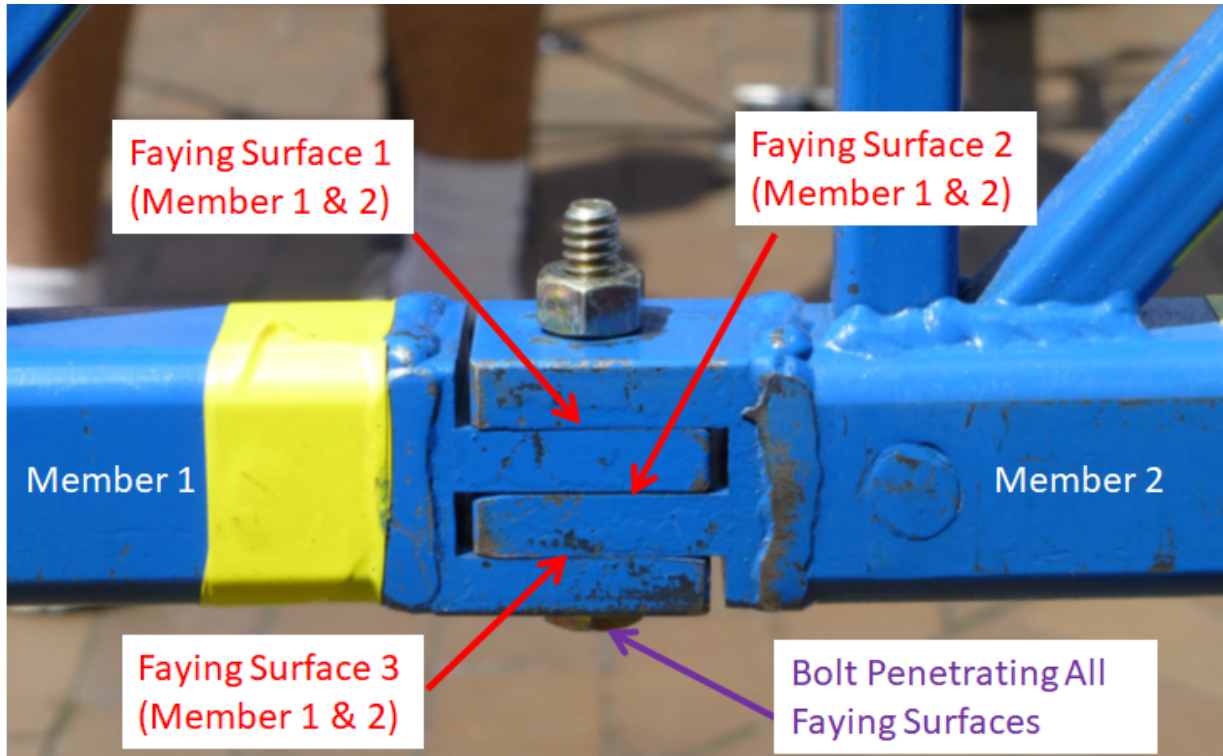
9.4.4 Each individual nut shall at least fully engage the threads of the matching bolt. That is, the terminal threads of the bolt shall extend beyond or be flush with the outer face of the nut. The threads of the nut shall match the bolt so that installation and removal require relative rotation.

Example 1: Case where three members touch at different locations and the requirements of 9.4.1 are met. This connection also meets the requirements of 9.4.2, 9.4.3, and 9.4.4.

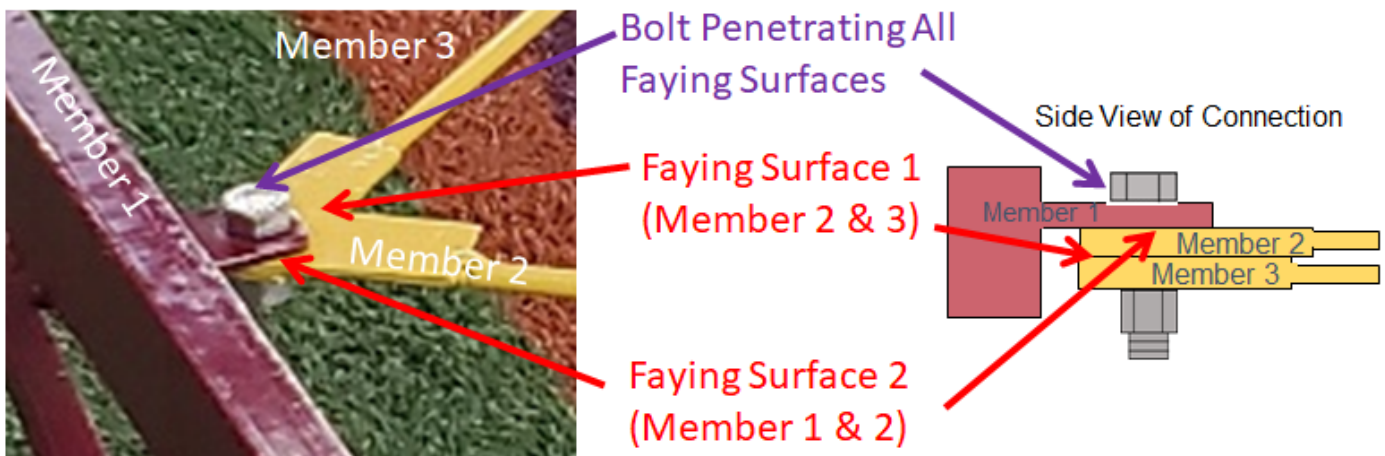


Loose Bolt Secured with Loose Nut
Penetrating Faying Surfaces 1 and 2
(Connection 3)

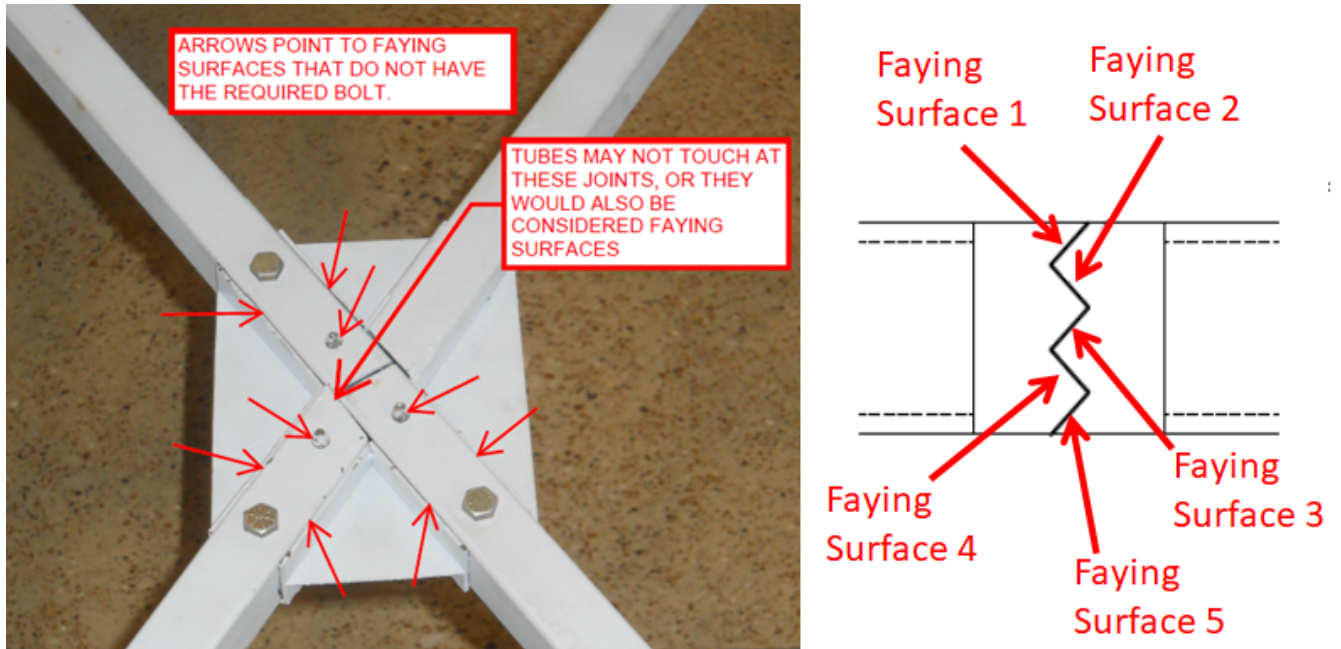
Example 2: A prohibited connection that does not meet the requirement that there can be at most two faying surfaces associated with each member being connected (9.4.2).



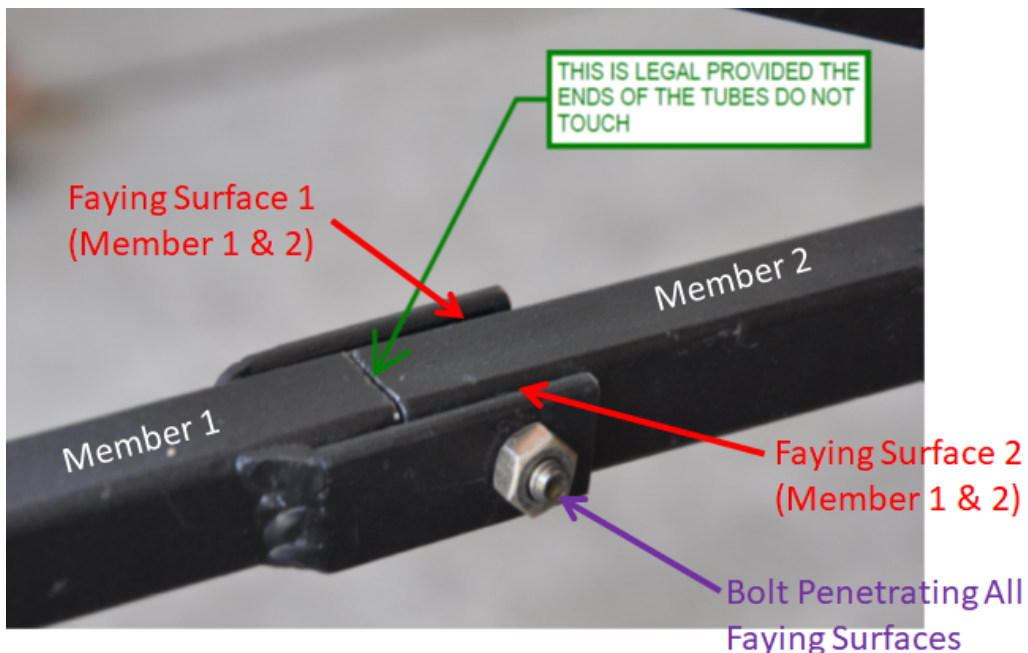
Example 3: A legal connection that involves more than two members that meets the requirements of 9.4.1. This connection also meets the requirements of 9.4.2, 9.4.3 and 9.4.4. There are at most two faying surfaces associated with each member being connected since there are three members involved in the connection.



Example 4(a) and 4(b): Prohibited connections where all contact points are not treated as faying surfaces as specified in 9.4.2.1. Since any point of contact between members creates a faying surface, these points of contact need to be penetrated by at least one loose bolt secured by a loose nut. There are also more than 2 faying surfaces associated with each member being connected (9.4.2).

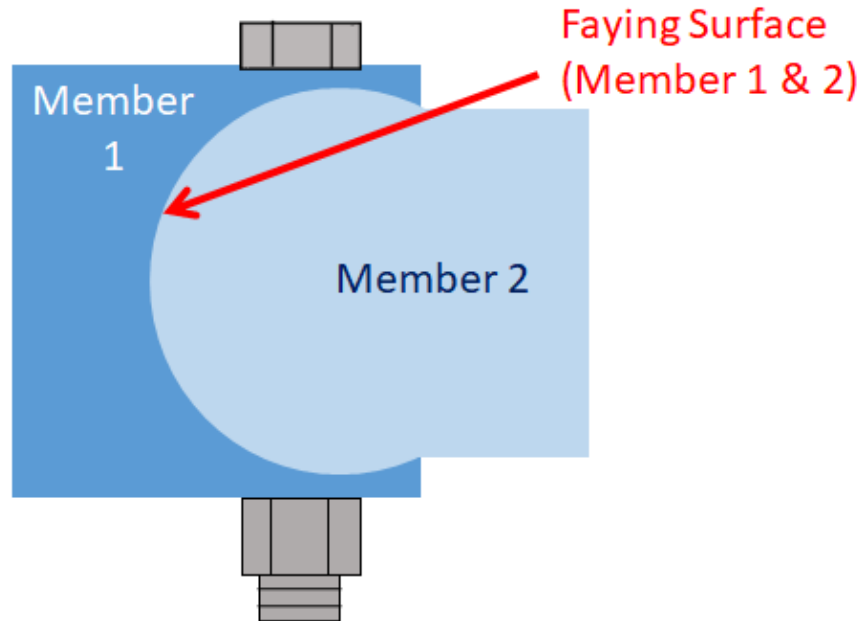


Example 5: A legal connection provided that the ends of the tubes do not meet resulting in the formation of a faying surface at the contact point (9.4.2.1).

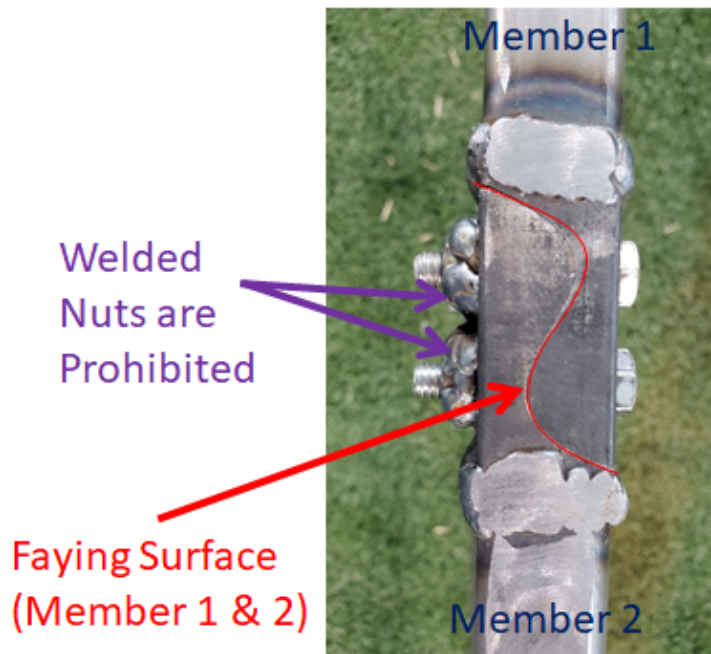


Example 6(a) and 6(b): Connections with prohibited curved faying surfaces (9.4.2.2).

Connection is interlocking if the curved faying surface extends beyond a semi-circular or semi-spherical arc.

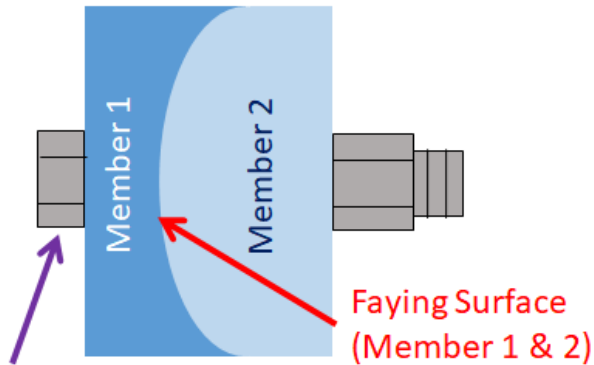


Faying surfaces that are curves with an inflection point are illegal.



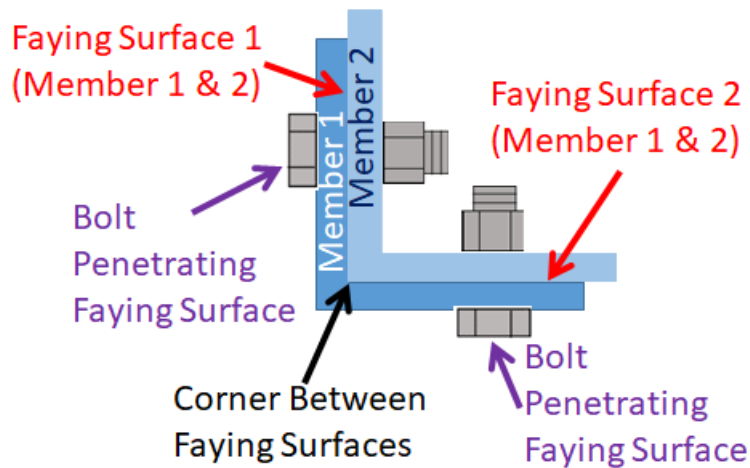
Example 7(a), 7(b), and 7(c): Connections with legal curved faying surfaces (9.4.2.2).

Connection with a faying surface that is a gradual curve that makes an arc less than 180°

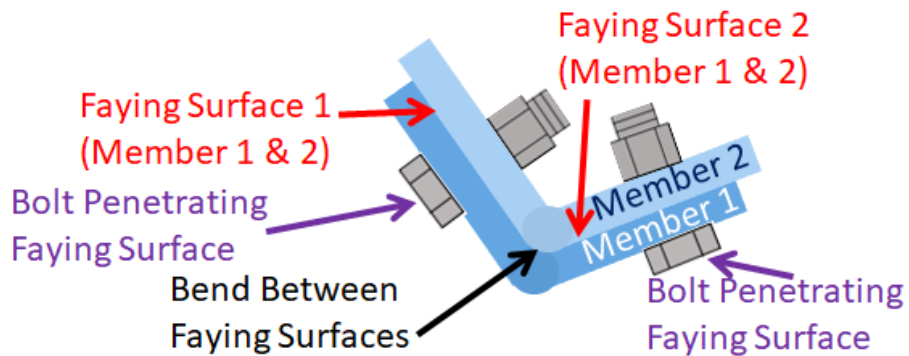


Bolt Penetrating All Faying Surfaces

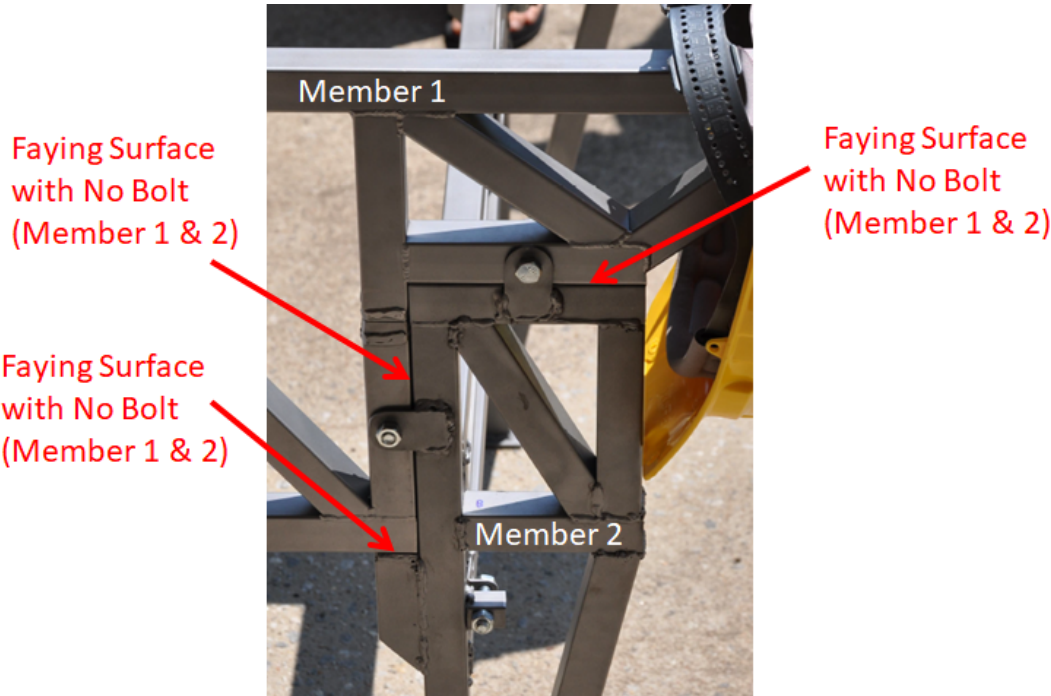
Connections with faying surfaces on either side of a corner



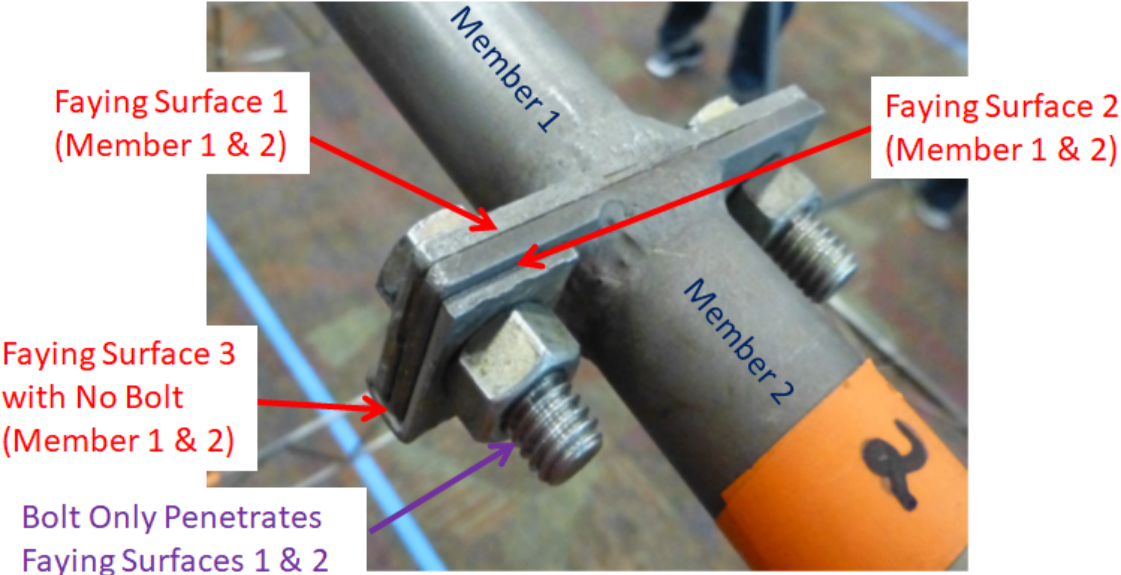
Connections with faying surfaces on either side of a bend



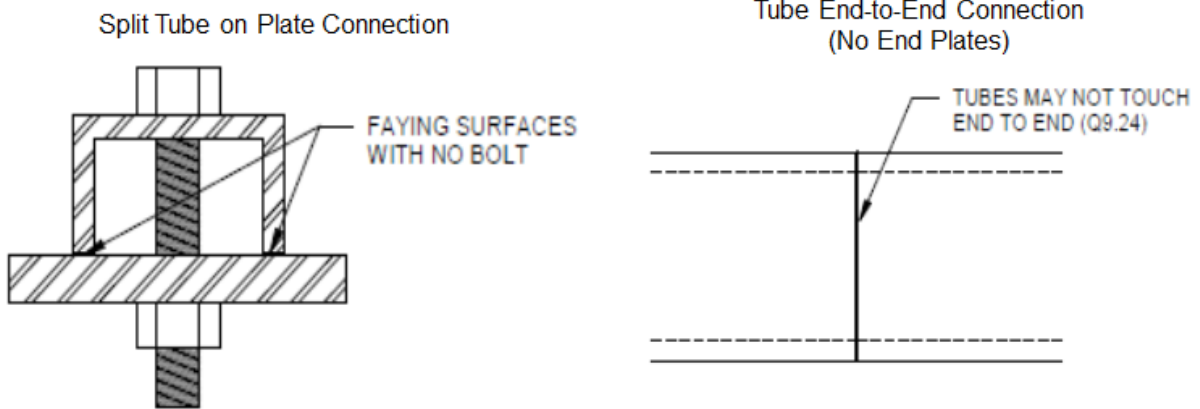
Example 8: A prohibited connection because all faying surfaces are not penetrated by at least one loose bolt secured by a loose nut (9.4.2.3).



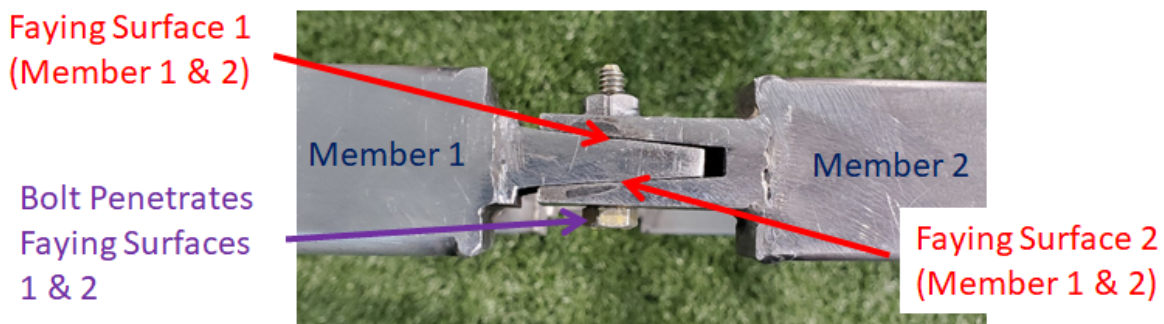
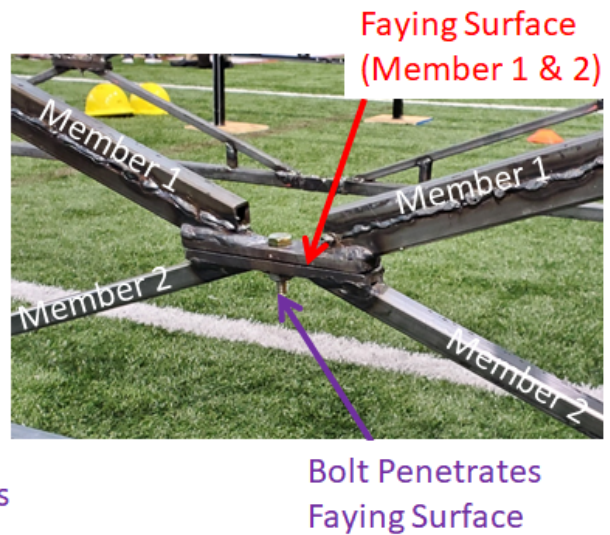
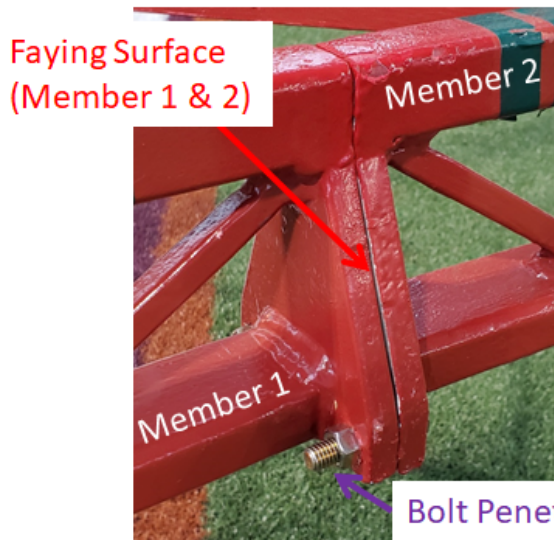
Example 9: A prohibited connection because all faying surfaces are not penetrated by at least one loose bolt secured by a loose nut (9.4.2.3). The connection also violates the restriction on interlocking connections (9.4.2.5). The connection would be legal if it did not have the saddle plate.



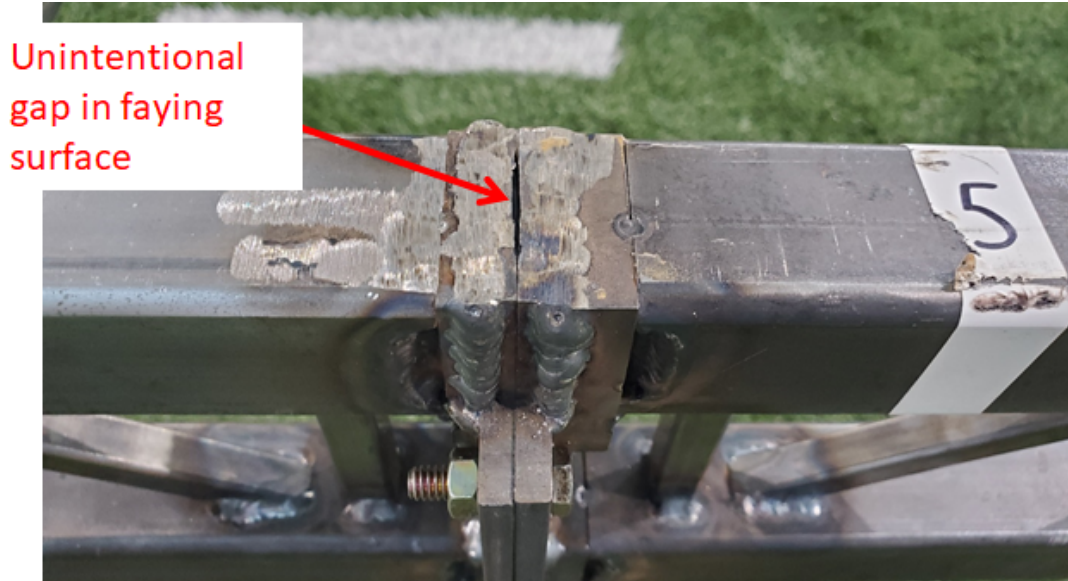
Example 10(a) and 10(b): Prohibited connections because all faying surfaces are not penetrated by at least one loose bolt secured by a loose nut (9.4.2.3).



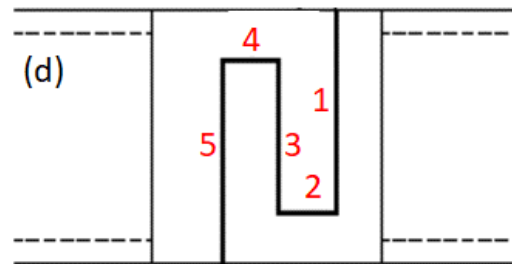
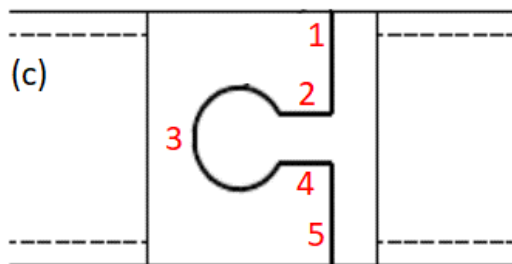
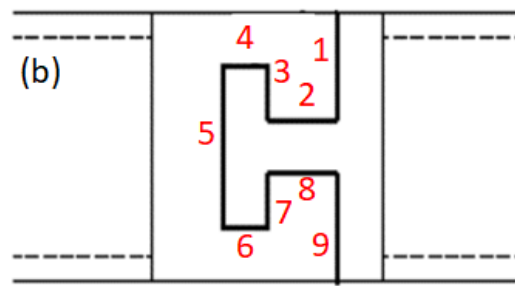
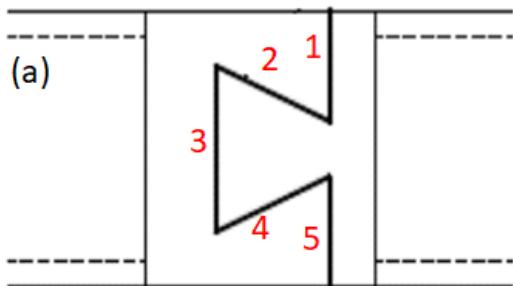
Example 11(a), 11(b), and 11(c): Legal connections because all faying surfaces are penetrated by at least one loose bolt secured by a loose nut (9.4.2.3) and all requirements of 9.4 are met.



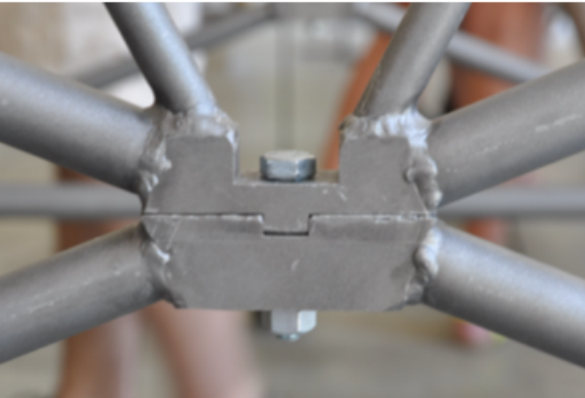
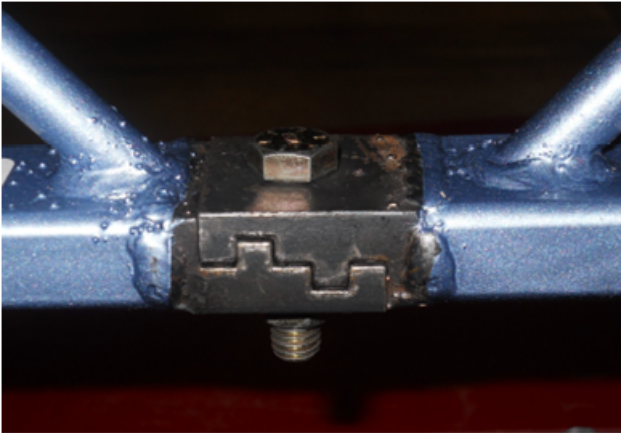
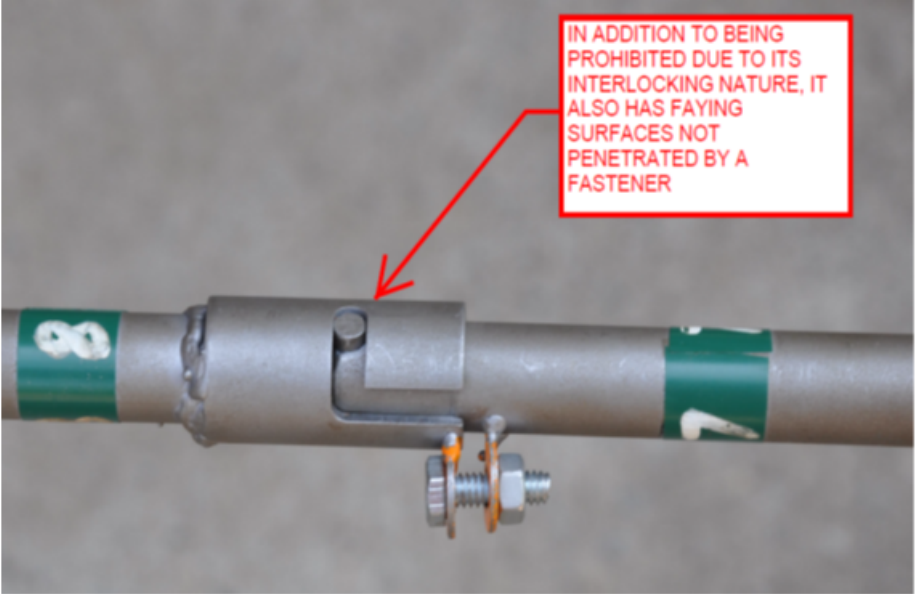
Example 12: Connection with a minor, unintentional gap between faying surfaces of members due to member and fabrication imperfections that is allowed and would be treated as a continuous faying surface since it is not large enough to resist movement without the presence of a bolt (9.4.2.4).



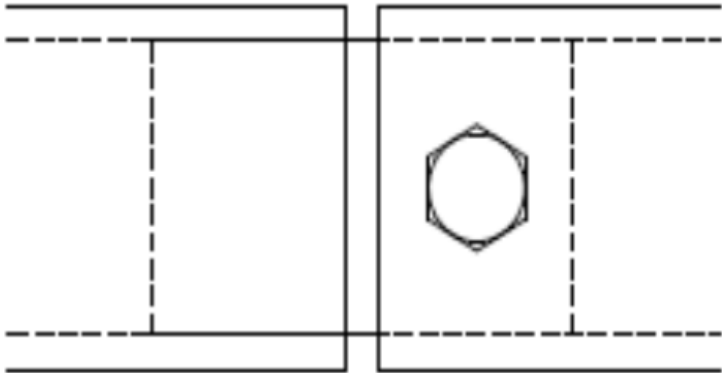
Example 13(a), 13(b), 13(c), and 13(d): Prohibited interlocking connections (9.4.2.5) where there also are more than 2 faying surfaces associated with each member being connected (9.4.2). The faying surfaces are numbered.



Example 14(a), 14(b), 14(c), 14(d), and 14(e): Prohibited interlocking connections (9.4.2.5) where there also are more than 2 faying surfaces associated with each member being connected (9.4.2). For all cases shown, the bolt does not penetrate all faying surfaces (9.4.2.3).



Example 15(a), 15(b), and 15(c): Prohibited tube-in-tube/sleeved connections (9.4.2.5).



Examples 16(a), 16(b), 16(c), 16(d), and 16(e): Legal connections.

