2nd Edition

The JVI Vector Connector

User Guidelines

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INTRODUCTION

JVI designed the Vector Connector for use in shear connections between precast concrete elements such as double-tee flanges, slabs, wall panels and others. Prior to the development of the Vector Connector, the precast concrete industry had to rely on various other shear connectors that did not perform to the industry's rigorous standards. JVI specifically developed the Vector Connector to meet the high-performance needs of the precast concrete industry. **JVI holds a patent on the Vector Connector**.

Additional testing performed by the University of Wisconsin—Milwaukee forms the basis for this edition of the JVI Vector Connector Guidelines. Testing showed that a 3-in.-long weld is adequate to develop the basic capacity of the Vector Connector (instead of the 4 in. of weld previously indicated). By using the shorter, 3-in.-long weld, less heat is generated than with the previously specified weld and more field tolerance is available.

Professor Michael Oliva at the University of Wisconsin—Madison developed the testing procedure, which followed the PCI PRESSS program testing criteria, to specifically evaluate various types of connections used by the precast concrete industry. The Vector Connector was tested in vertical and horizontal shear, tension, and cyclical shear—with and without tension—to simulate a seismic event. Precast concrete slabs (4 ft. square by 4 in. thick) were used for these tests. See the following reports for testing procedures, results, and further discussions of the Vector Connector:

- Testing of JVI Flange Connector for the Precast Concrete Double-Tee systems by Professor Michael J. Oliva, University of Wisconsin—Madison, College of Engineering, June 2000.
- JVI Vector Connector for the Precast Double-Tee Members: Report on The Results of Laboratory Testing by A. Fattah Shaikh, P.E., Ph. D, Fellow: ASCE, ACI, PCI, Professor of Structural Engineering and Eric P. Feile, M.S. , Research Assistant, September 2002
- Additional Testing of the JVI Vector Connector in 4" Slabs. By A. Fattah Shaikh, P.E., Ph.D., Fellow: PCI, ASCE, ACI, Professor Emeritus of Structural Engineering and Eric P. Feile Former Research Assistant University of Wisconsin—Milwaukee, September 2004

The intent of these guidelines is to allow Vector Connector users to benefit from its full, tested capacities.

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ENGINEERING

1. **Space the Vector Connector to provide capacity for all the forces the connection will encounter.** Typical forces may be transferred from the diaphragm and may include, but are not limited to, vertical forces from wheel loads and wind loads, thermal changes, and construction loads.
2. **Detail the Vector Connector in its proper position** (see attached details for proper positioning). Negative draft is the intended position for maximum performance (as shown through testing). Alternate positioning of the Vector Connector, other than the negative draft position, may prove acceptable with further testing. Detail the Vector Connector for proper concrete coverage and interaction with the concrete reinforcement. The Vector Connector has been tested with welded-wire reinforcement (WWR) between, above, and below its legs to simulate a 4-in. double-tee flange. The Vector Connector is not limited to use in a 4-in.-thick double-tee flange. It can be used in other precast, prestressed concrete products that require load transfer across joints and which meet the intent of the Vector Connector testing.
3. **Show the details for the setting holes on the Vector Connector faceplate on the construction drawings. These holes must be consistent with the form conditions and should be coordinated during production to ensure the appropriate setting blockout is provided.**
4. **Show the alignment position of the Vector Connector on the shop drawings by means of a "-" symbol.** This symbol can be viewed on the top side of the leg and on the upper left side of the faceplate when properly positioned. The use of the JVI blockout, or any other similar, four-sided setting device, is recommended. The Vector Connector face must be in full contact with the blockout. The blockout creates space to allow for expansion of the faceplate during welding. The blockout must be in full contact with side form. For quality control prior to concrete placement, production personnel can see the "-" symbol on the connector leg when inspecting the product setup. Inspection after concrete placement is also possible because the symbol remains visible on the upper left side of the exposed faceplate **(see drawing numbers JVI-SK5 and JVI-SK6)**.
5. **Size the WWR width to be 4 in. less than the actual width of the precast concrete product**. **The WWR should be 2 in. from the edge on each side of the precast concrete product** for proper connector and WWR placement. This means both wires of the WWR, **the longitudinal and transverse wires, must be detailed and ordered to not interfere with the proper placement of the Vector Connector and the WWR (see drawing numbers JVI-SK1, JVI-SK2, and JVI-SK3)**. As an example: if the production width is 11 ft- 11 in. wide (at mid-height), then the WWR should be a maximum of 11 ft– 7 in. wide.
6. **Design the weld and the erection bar for the calculated forces. The size, length, and type of weld should be specified for the type of erection bar used. The erection bar can be a flat or round. Various erection bar widths will be required to compensate for the various joint widths. The erection bar length should not be less than the length of the weld. Misalignment between adjacent Vector Connectors can occur and longer erection bars are required to compensate for this condition.** Note that the latest testing by Dr. Shaikh at the University of Wisconsin—Milwaukee used a 1/4 in. x 3-in.-long weld to develop the capacity of the Vector Connector in vertical and horizontal shear. The use of a weld longer than 3 in. may create unwanted conditions. A 3-in.-long weld develops a tensile force in excess of 6 kips for ASTM A36 grade steel and 11 kips for ASTM A304 stainless steel. **Over-welding is not acceptable and should be indicated as such on the contract and shop/erection drawings (see drawing numbers JVI-SK1, JVI-SK2, and JVI-SK6)**. **Caution: round erection bars use a flare-bevel weld, which may create higher welding temperature. The maximum round erection bar should be 1" diameter. For joint requiring a larger diameter erection bar, a flat erection bar should be used.**
7. **For applied loads less than the capacity of the Vector Connector, a smaller size weld may be used as calculated by the Engineer of Record and/or a precast concrete specialty engineer.**

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ENGINEERING (Continued)

8. **The flat or round erection bars used for the field connection plate should have a minimum thickness of 3/8 in. The maximum thickness of the erection bar should be governed by the actual size of the joint and the type of weld. Never detail or use multiple erection bars between adjacent Vector Connectors.** Should the joint width be large enough to induce a bending moment in a flat erection bar, a precast concrete specialty engineer should be consulted for a larger flat erection bar thickness. The use of round erection bars may require additional welding, thus generating excessive heat. If using round erection bars, the applied weld size may vary and could result in questionable quality.
9. **Place the WWR between, above or below the anchor legs of the Vector Connector**. JVI originally design the Vector Connector to be vertically centered in a concrete thickness of 4 in. (or more) with the WWR centered between legs of the Vector Connector. Testing has shown that the WWR does not have to be located between the legs of the Vector Connector. When centered vertically in a 4-in.-thick flange, there is adequate concrete coverage for most applications (**see drawing numbers JVI-SK1, JVI-SK2, and JVI-SK3)**.
10. **Design and install all welds for making connections in accordance with the latest edition of the American Welding Society (AWS) manual.**
11. Consult a precast concrete specialty engineer if greater vertical shear and tension capacities are desired because additional reinforcing or field welds, respectively, may be required. Total weld capacity should not exceed 140% of the connector capacity determined through the testing program noted previously.
12. Consult a precast concrete specialty engineer if greater tension and/or seismic capacities are needed. In these cases, a small rod or heavy wire may be threaded through the hole at each end of the Vector Connector's anchor legs to help prevent pullout types of failures. Additional testing may be required.
13. **Develop, test and approve a welding procedure specification prior to each project. Each field welder shall be pre-qualified for this welding procedure. A fillet weld should be specified for the flat erection bar connection. A flare bevel weld should be specified for the round erection bar connection.**
14. **Have the certified welder, the welding inspector, the Engineer of Record, and the precast concrete specialty engineer review the welding procedures prior to any welding.** Sample welding of the connection should be performed, reviewed and approved. All specifications and details indicated on the construction drawings shall be followed. Any inconsistencies in the construction documents should be brought to the attention of the Engineer of Record. **The welder shall not oversize the weld.**
15. **Include flat or round erection bars of various widths on field material hardware lists. See item 6 and 8 for erection bar requirements.**

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PURCHASING

1. **Order welded-wire reinforcement (WWR) 4 in. narrower than the product width. The WWR should be 2 in. from the edge on each side of the precast concrete product** The WWR should be a minimum of 2 in. from the edge on each side of the precast concrete product. Verify the correct WWR size with engineering and production (**see drawing numbers JVI-SK1, JVI-SK2, and JVI-SK3).**
2. **Choose the Vector Connector with the correct hole locations to fit the side forms.** Different hole locations are available. Coordinate hole locations with engineering and production.
3. **Select JVI blockouts to fit the product design and casting form.** If not using the JVI blockouts, have the blockout fabricated with concrete relief on all sides. The relief allows for expansion of the Vector Connector when the connection is made in the field. Verify chosen blockouts with engineering and production. JVI Magnetics offers a metal blockout with or without magnets that can be custom made to the side form.
4. **Order various width field erection bars to accommodate field-placement conditions.** Flat or round erection bars can be used. Coordinate erection bar sizes with engineering and erection.

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PRODUCTION

1. **Tightly place the Vector Connector against the setting blockout and side form to eliminate misorientation. Misorientation of the Vector Connector includes not being parallel to the side form and being recessed more than the blockout thickness from the side form. Any misorientation should be corrected.** If not corrected, welding problems may occur in the field. Typical attachment of the Vector Connector/blockout system includes placing a bolt through to side form and attaching it to a wing nut on the back side. These bolts must be removed prior to stripping of the precast concrete product. An alternate system could include magnets. Common causes of misorientation are over-width sized welded-wire reinforcement (WWR), unsupported WWR, unsecured fastening, not being placed properly, and plant personnel walking in the formwork near the location of the Vector Connector.
2. **Use a JVI setting blockout or equal with a positive drafted side form**. **This device will allow for the proper orientation of the Vector Connector, with a negative draft position of the Vector Connector. The backside of the mounting blockout, which is against the side form, must conform to the shape of the side form. This will allow the bottom edge of the Vector Connector to be placed as close to the side form as possible. This positioning is required so that the Vector Connector performs as described in the testing.** If other blockouts are used that place the connector deeper, both vertically and horizontally, into the concrete, or at a different orientation, additional testing should be performed to determine the capacity of the connection.
3. **Place the Vector Connector such that the "-"symbol is visible on the top side of the leg and at the top left corner of the faceplate to ensure capacities determined during testing. The Vector Connector has a "-" and "+"symbol engraved on the faceplate and legs.** Other orientations should be tested for capacity of the connection prior to use.
4. **Check the Vector Connector positioning in the form prior to concrete placement. Any misorientation should be corrected.**
5. **Clean and keep clear the top and bottom edge and all sides of the Vector Connector from any concrete**. The JVI mounting blockout will keep these edges clean if fastened properly and in good condition.
6. **Order and place the WWR to be 2 in. clear of each side form.** As an example: if the production width is 11 ft- 11 in. wide (at mid-height), then the WWR should be 11 ft– 7 in. wide.
7. **Place WWR between, above or below the anchor legs of the Vector Connector**. The Vector Connector was originally designed to be vertically centered in a concrete thickness of 4 in. or more, with the WWR centered between legs of the Vector Connector. When centered, adequate concrete coverage of the Vector Connector is achieved for most applications (**see drawing numbers JVI-SK1, JVI-SK2, and JVI-SK3)**. If WWR is placed above or below the connector legs, proper concrete coverage should be checked to verify it meets the applicable code provisions.
8. **Use a bolting, magnetic, or other positive fastening system for connection of the Vector Connector to the formwork**. The 5/16-in.-diameter holes in the Vector Connector faceplate allow for use of a 1/4-in.-diameter bolt or pin.
9. **Do not remove or cut any reinforcement in or around the location of the Vector Connector.** With permission of a precast concrete specialty engineer, adjust the size and detail of the reinforcement.
10. **Prior to concrete placement, inspect the Vector Connector.** Inspection should be a routine Quality Assurance (QA) operation and be a part of your PCI Plant Certification Program and Quality Systems Manual. See item 2 in "Production."
11. **Once the formwork is stripped from the precast concrete product, inspect the Vector Connector for cleanliness and proper positioning**. If necessary, remove any concrete paste on the face of the connector, sides, and top and bottom edges. Faceplate cleanliness minimizes the need for the field welder to clean the Vector Connector prior to the welding process.

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PRODUCTION (Continued)

12. If the Vector Connector is used in a pre-topped parking garage double tee, tool or grind **the concrete edge at the top surface and above the Vector Connector that is created by the blockout to prevent edge spalling from wheel loads (as well as along the continuous edge of the double tee)**.

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ERECTION

1. **Develop, test and approve a welding procedure prior to each project. Each field welder shall be pre-qualified for this welding procedure.**
2. **Require a pre-job meeting to review welding procedures between the certified welder, the welding inspector, the Engineer of Record, and the precast concrete specialty engineer prior to welding. Invite a JVI representative to this meeting.** At this meeting, perform, review, and approve sample welding of the connection. Follow all specifications and all details indicated on the drawings. Any inconsistencies should be brought to the attention of the Engineer of Record. **Advise all welders to not to oversize the weld; Do not accept any oversize welds.**
3. **All welds for making connections should be designed and installed in accordance with the latest edition of the American Welding Society (AWS) manual.**
4. **Specify the size, length and type of weld for the type of erection bar used. The erection bar can be a flat or round. Various erection bar widths will be required to compensate for the various joint widths.**
5. **The erection bar length should not to be less than the length of the required weld. Misalignment between adjacent Vector Connectors can occur and longer erection bars are needed to compensate for this condition.** Note that the latest testing by Dr. Shaikh at the University of Wisconsin—Milwaukee used a 1/4 in. x 3-in.-long weld to develop the capacity of the Vector Connector in vertical and horizontal shear. The use of a weld longer than 3 in. may create unwanted conditions. A 3-in,-long weld develops a tensile force in excess of 6 kips for ASTM A36 grade steel and 11 kips for ASTM A304 stainless steel. **Over-welding is not acceptable and should be indicated as such on the contract and shop/erection drawings** (**see drawing numbers JVI-SK1, JVI-SK2, and JVI-SK6)**. **Caution: round erection bars use a flare-bevel weld, which may create higher welding temperature. The maximum round erection bar should be 1" diameter. For joint requiring a larger diameter erection bar, a flat erection bar should be used.** For applied loads less than the capacity of the Vector Connector, a smaller size weld may be used as calculated by the Engineer of Record and/or a precast concrete specialty engineer.
6. **Various width erection bars will be required to weld adjacent Vector Connectors as the joint width will vary. DO NOT weld multiply erection bars together to make the connection.**
7. **Place the erection bars parallel to the top edge of the Vector Connector and within the vertical limits no lower than mid-depth and ¼ in. below the top edge of the Vector Connector (see drawing number JVI-SK1 and JVI-SK2).** Flat or round erection bars should be set perpendicular to the faceplate and should not be in a skewed position relative to the faceplate. Welding below mid-depth can reduce the quality of weld and could cause different performance characteristics of the Vector Connector system
8. Should misalignment occur, use longer erection bars and **maintain centered welds within Vector Connector faceplates.**
9. **Never use multiple erection bars between adjacent Vector Connectors.**
10. **Place the flat or round erection bars such that their top surfaces are ¼ in. below the top edge of the Vector Connector and no more than 3/4 in. down from the top of the Vector Connector (see drawing number JVI-SK1 and JVI-SK2).**
11. **Use a setting tool to help provide for proper erection bar placement and ease of welding to the erection bar.** Other procedures to set the flat or round erection bar may be used as long as the erection bar is in the proper position **(see drawing number JVI-SK6).**
12. **Center the flat or round erection bar for the field connection within the width of the connection (see drawing number JVI-SK6). Do not weld within ¾ in. from the ends of the faceplate.**
13. **Should misalignment between adjacent Vector Connectors occur, use longer erection bars and maintain centered welds within the Vector Connector faceplates. In addition, consult a precast concrete specialty engineer for welding changes and approvals.**

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ERECTION (Continued)

14. **Use flat or round erection bars for the field connection with a minimum thickness of 3/8 in. Maximum thickness of the erection bar should be governed by the actual size of the joint and the type of weld. Never detail or use multiple erection bars between adjacent Vector Connectors. Use of round erection bars may require additional welding, thus generating excessive heat.** The larger the diameter round used, the larger the weld required, therefore creating more unwanted heat. When welding to these types of erection bars, the applied weld size will vary and thus result in questionable quality. Should the joint width be large enough to induce a bending moment in the flat erection bar, a precast concrete specialty engineer should be consulted for a larger flat erection bar thickness.
15. **Specify a fillet weld for the flat erection bar connection. Specify a flare bevel weld for the round erection bar connection.**
16. **Caution: flare bevel weld with a round may create higher welding temperature.** The larger diameter of round erection bars will use larger welds.
17. **Periodically inspect welding and erection bar placement to ensure the Vector Connector will perform as designed.**

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RECOMMENDATIONS

1. **Design the Vector Connector and the field connection for calculated loads only. Use the weld required for the calculated loads; the maximum fillet weld shall be ¼ in. x 3 in. long. Do not oversize the weld for added safety; excessive weld adds excess heat, which could affect the performance of the connection.**
2. **Place the Vector Connector in the negative draft position with positive fastening and edge relief system. Use the JVI mounting blockout or equal.**
3. **Keep the top and bottom edge as well as the sides of the Vector Connector clean.**
4. **Use a flat erection bar and a fillet weld for the field connection. Use a flare bevel weld when using a round erection bar. Do not use multiple erection bars.**
5. **Center the field weld within the width of the Vector Connector faceplate. Do not weld within ¾ in. from the ends of the faceplate.**
6. **Place the erection bar parallel to the top edge, ¼ in. below the top edge and above mid-depth of the Vector Connector.**
7. **Should misalignment between adjacent Vector Connectors occur, use longer erection bars and maintain centered welds within the Vector Connector faceplates.**
8. **DO NOT OVER WELD!**

For further information and discussion, please contact JVI's Chuck Magnesio, 413-442-4147.

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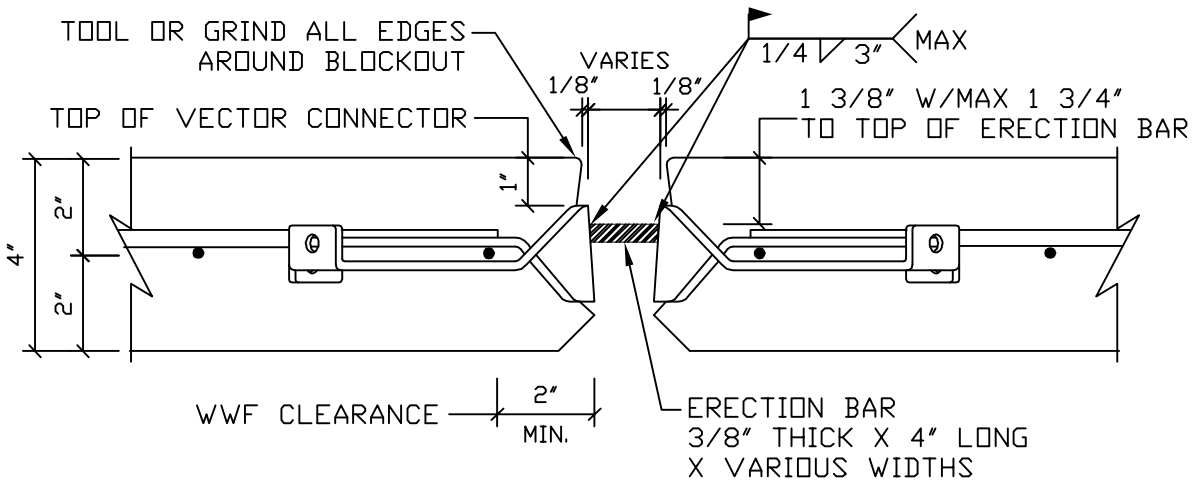

VECTOR CONNECTOR
NEGATIVE DRAFT

NOTES:

1.) CENTER WELD AND ERECTION BAR WITHIN FACEPLATE OF VECTOR CONNECTOR DO NOT WELD WITHIN 3/4" OF THE CORNERS.
2.) DO NOT OVER WELD; 3" MAXIMUM WELD LENGTH.
3.) ERECTION BAR TO BE HORIZONTAL.
4.) ALL EDGES OF VECTOR CONNECTOR MUST BE FREE OF CONCRETE.
5.) LOCATE LONGITUDINAL AND TRANSVERSE WIRE OF WWF MESH SO NOT TO INTERFERE WITH VECTOR CONNECTOR LEG ENDS; ORDER WWF MESH WITH PROPER CLEARANCE.
6.) MESH CAN BE LOCATED ABOVE, BELOW OR BETWEEN VECTOR LEGS.
7.) DETAIL OF JOINT BEYOND NOT SHOWN; SEE JVI-SK4.
8.) FOR STAINLESS STEEL VECTOR CONNECTORS, USE STAINLESS STEEL ERECTION BAR AND USE WELDING ELECTRODE E308.
9.) FOR "J" COATED VECTOR CONNECTORS (A36), USE A36 GRADE ERECTION BARS AND USE WELDING ELECTRODE E70XX.
10.) DETAIL USING ROUND ERECTION BAR; SEE JVI-SK2.
11.) ORDER VARIOUS WIDTH ERECTION BARS.
12.) LONGER ERECTION BARS MAY BE REQUIRED DUE TO VC MISALIGNMENT- SEE JVI-SK6.

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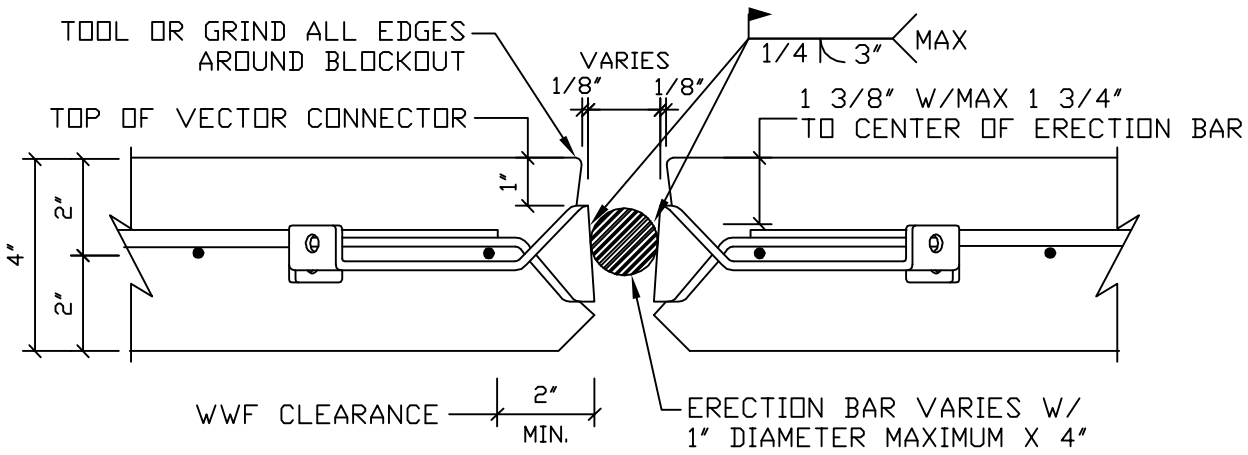
JVI-SK1



VECTOR CONNECTOR
NEGATIVE DRAFT

NOTES:

1.) CENTER WELD AND ERECTION BAR WITHIN FACEPLATE OF VECTOR CONNECTOR DO NOT WELD WITHIN 3/4" OF THE CORNERS.
2.) DO NOT OVER WELD; 3" MAXIMUM WELD LENGTH.
3.) ERECTION BAR TO BE HORIZONTAL.
4.) ALL EDGES OF VECTOR CONNECTOR MUST BE FREE OF CONCRETE.
5.) LOCATE LONGITUDINAL AND TRANSVERSE WIRE OF WWF MESH SO NOT TO INTERFERE WITH VECTOR CONNECTOR LEG ENDS; ORDER WWF MESH WITH PROPER CLEARANCE.
6.) MESH CAN BE LOCATED ABOVE, BELOW OR BETWEEN VECTOR LEGS.
7.) DETAIL OF JOINT BEYOND NOT SHOWN; SEE JVI-SK4.
8.) FOR STAINLESS STEEL VECTOR CONNECTORS, USE STAINLESS STEEL ERECTION BAR AND USE WELDING ELECTRODE E308.
9.) FOR "J" COATED VECTOR CONNECTORS (A36), USE A36 GRADE ERECTION BARS AND USE WELDING ELECTRODE E70XX.
10.) DETAIL USING FLAT ERECTION BAR; SEE JVI-SK1.
11.) ORDER VARIOUS DIAMETER ERECTION BARS.
12.) LONGER ERECTION BARS MAY BE REQUIRED DUE TO VC MISALIGNMENT- SEE JVI-SK6.

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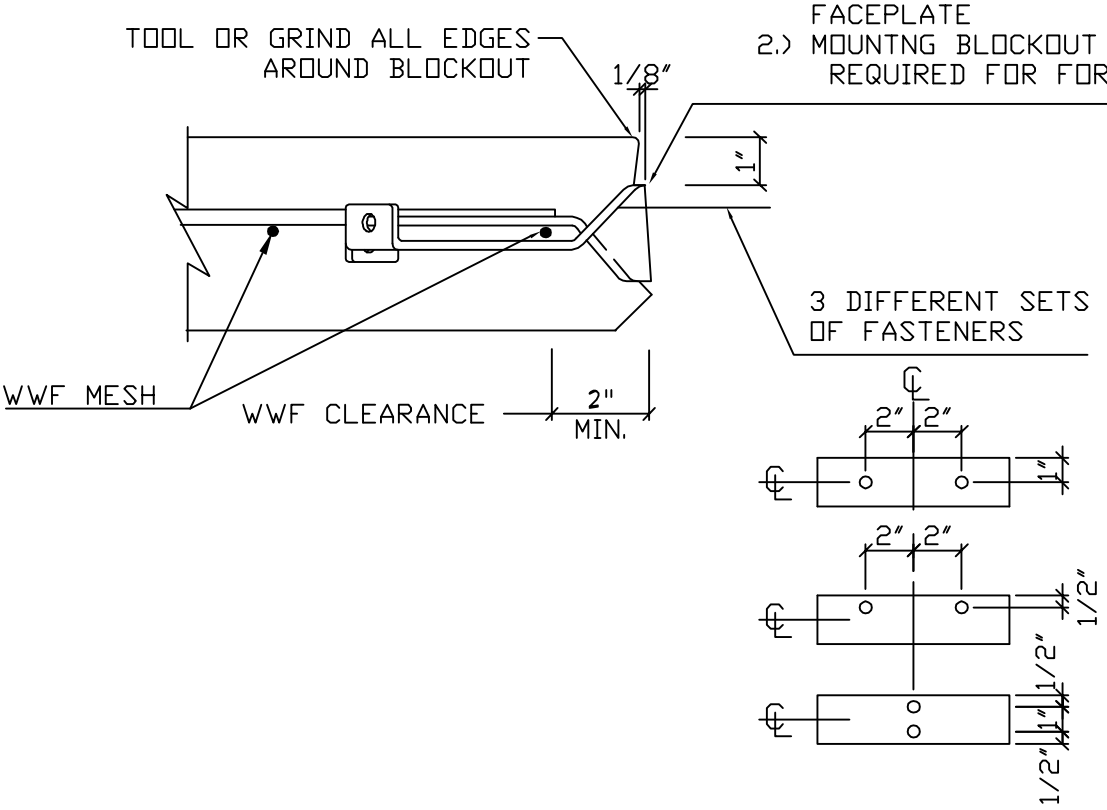
JVI-SK2

NOTES:
1.) NEGATIVE SYMBOL AT TOP LEFT HAND CORNER OF FACEPLATE
2.) MOUNTNG BLOCKOUT REQUIRED FOR FORMING



VECTOR CONNECTOR POSITONING
NEGATIVE DRAFT

NOTES:
1.) USE JVI MOUNTING BLOCKOUT OR EQUAL
2.) FIT VECTOR CONNECTOR TO SIDE FORM USING BOLTING SYSTEM, JVI MAGNETIC BLOCKOUT OR POSITIVE FASTENING SYSTEM.
3.) LOCATE LONGITUDINAL AND TRANSVERSE WIRE OF WWF MESH SO NOT TO INTERFERE WITH VECTOR CONNECTOR LEG ENDS; ORDER WWF MESH WITH PROPER CLEARANCE.
4.) MESH CAN BE LOCATED ABOVE, BELOW OR BETWEEN VECTOR LEGS.

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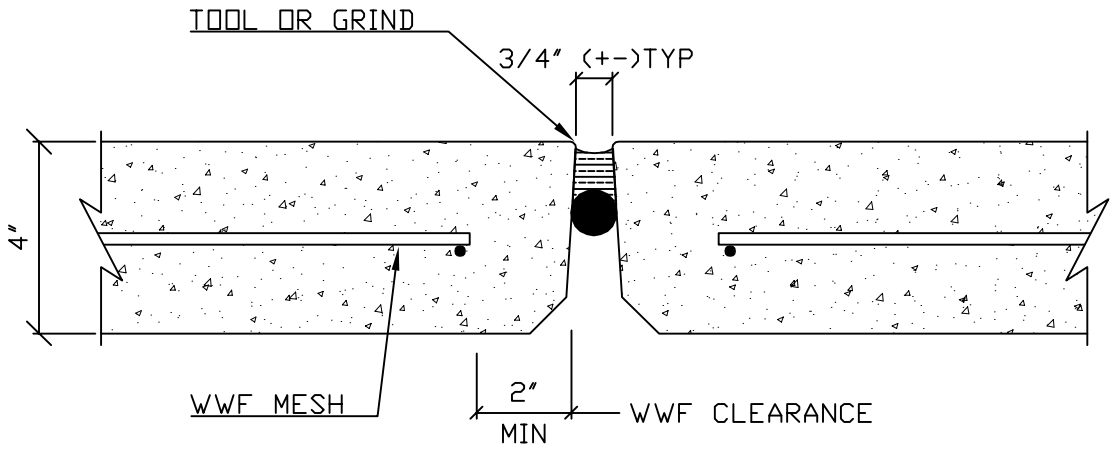
JVI-SK3



JOINT DETAIL BEYOND CONNECTION
SUGGESTED DETAIL

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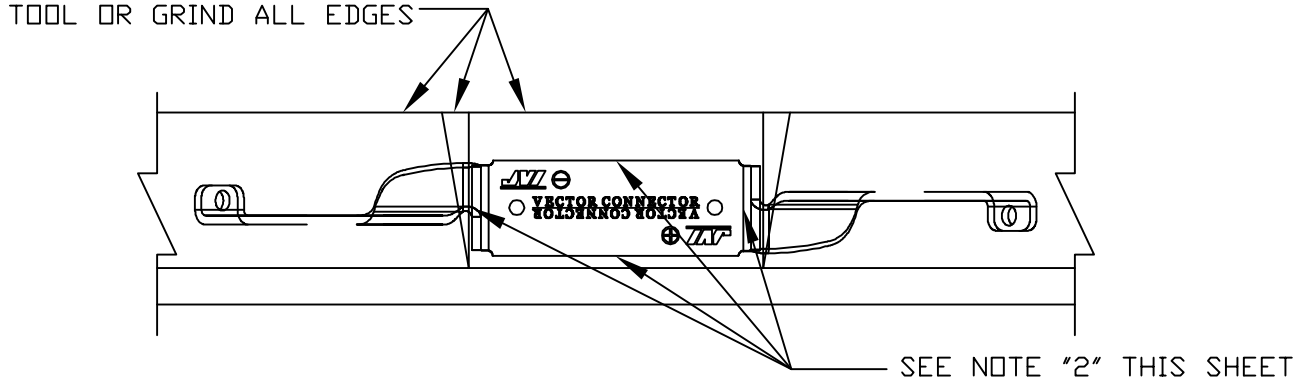
JVI-SK4



VECTOR CONNECTOR POSITONING
NEGATIVE DRAFT

NOTES:

1.) THE NEGATIVE SYMBOL, "-" SHOULD BE IN THE UPPER LEFT HAND CORNER OF THE VECTOR CONNECTOR FACEPLATE FOR PROPER PLACEMENT.
2.) ALL EDGES OF VECTOR CONNECTOR MUST BE FREE OF CONCRETE.
3.) BLOCKOUT CONCRETE AROUND ALL SIDES.
4.) FOR HOLE FASTENING LOCATION; SEE JVI- SK3.

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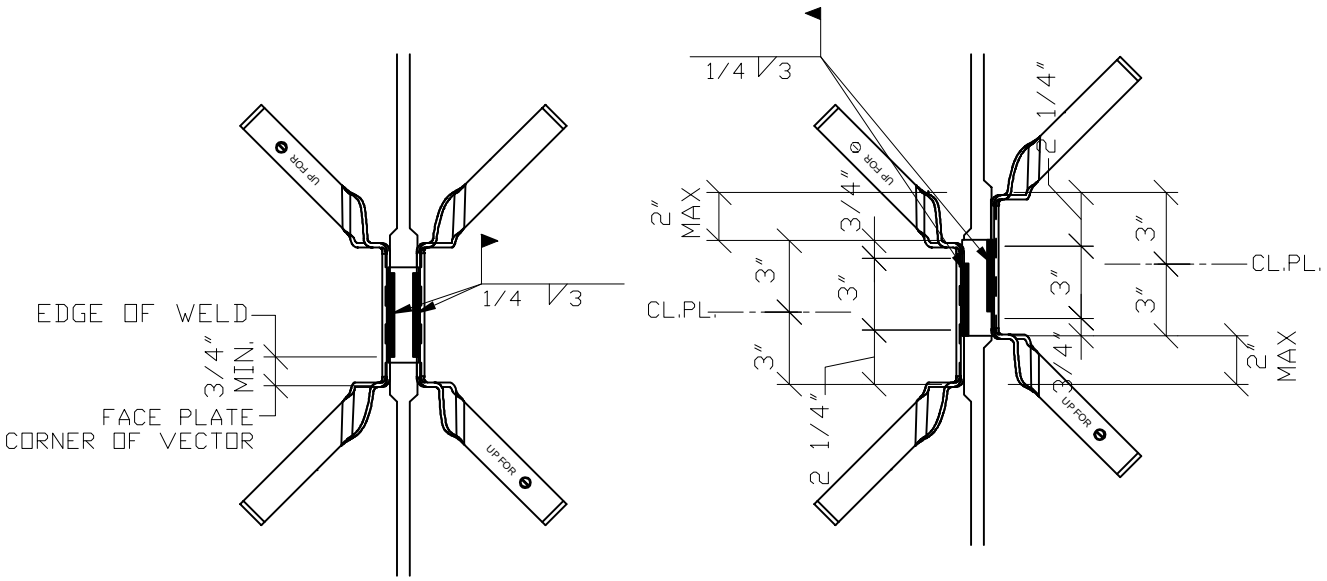
JVI-SK5



4" ERECTION BAR VECTOR CONNECTOR POSITONING NEGATIVE DRAFT

NOTES:

1.) THE NEGATIVE SYMBOL, "-" SHOULD BE VISIBLE WHEN IN PLAN (LOOKING DOWN) AT THE VECTOR CONNECTOR LEGS.

2.) ALL EDGES OF VECTOR CONNECTOR MUST BE FREE OF CONCRETE.

3.) WELD ERECTION BAR TO CENTER OF VECTOR CONNECTOR FACEPLATE. DO NOT WELD WITHIN 3/4" OF THE CORNERS.

4.) DO NOT OVER WELD. 3" WELD MAXIMUM WELD LENGTH. LOCATE LONGITUDINAL AND TRANSVERSE WIRE OR WWF MESH SO NOT TO INTERFERE WITH VECTOR CONNECTOR LEG ENDS; ORDER WWF WITH PROPER CLEARANCE.

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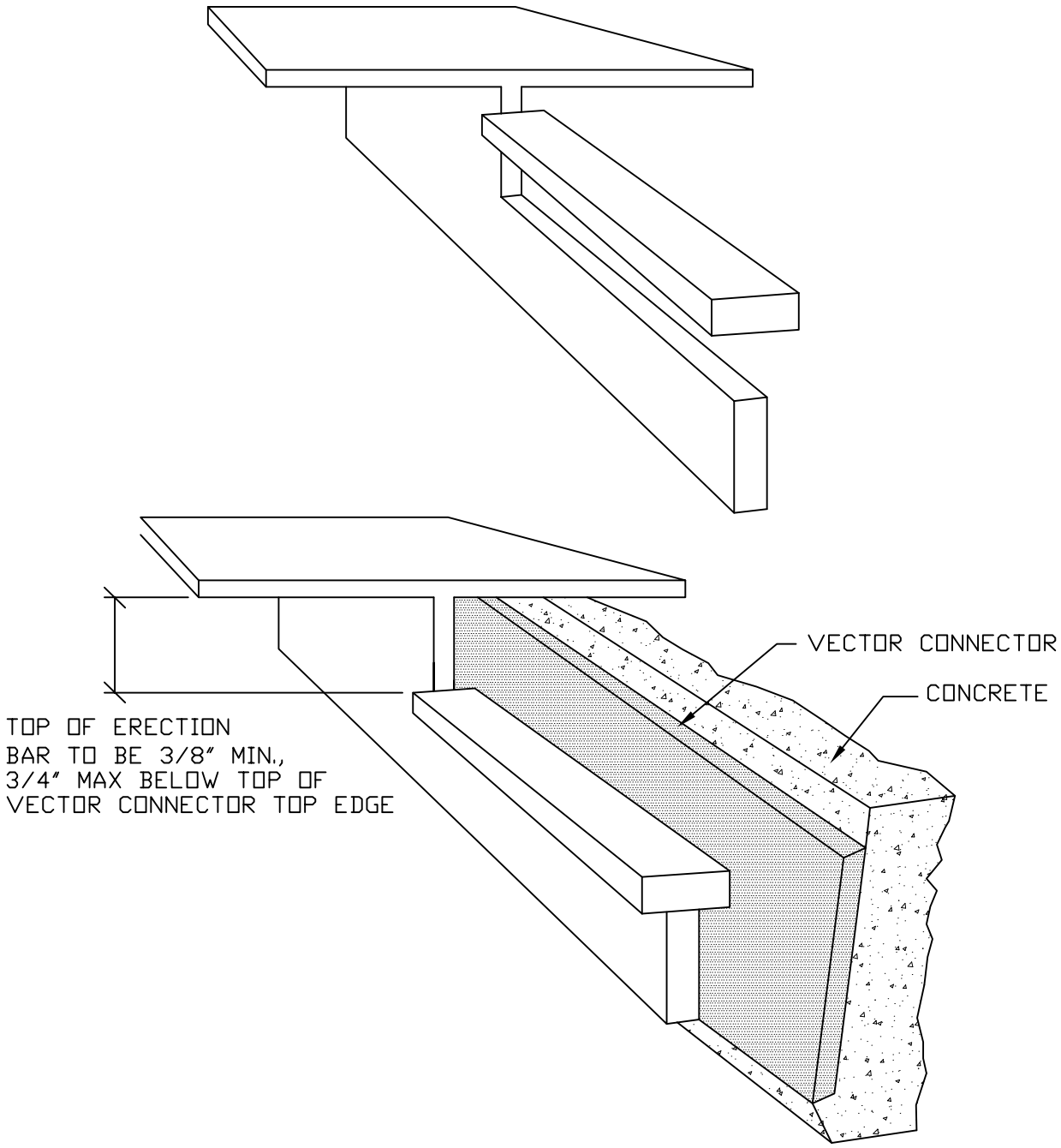
JVI-SK6



ERECTION BAR SETTING TOOL
SUGGESTED DETAIL

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