

# STEEL REPAIR PROCEDURES OPERATIONS MANUAL



New York State Department of Transportation  
Operations Division  
Office of Transportation Maintenance  
March, 2009

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## FOREWORD

This **Steel Repair Procedures Operations Manual** (module) has been constructed by the NYSDOT Main Office Bridge Maintenance Department with the assistance of the NYSDOT Main Office Structures Department. It has been put together to provide simple guidance for some common repairs required on NYS owned steel structures. The documents in this manual should not be taken as approved methods of repair however. All repairs should be performed with their own approved procedure, WPS, etc...

The NYSDOT Main Office Bridge Maintenance Department has developed this and other modules related to bridge maintenance, including Bearing Replacement and the Use of Sacrificial or Galvanic Anodes on In- Service Bridges. The goal is to eventually incorporate all of these modules as chapters in a Bridge Preservation Manual.

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## GENERAL NOTES

1. Paint shall be removed at least 6 inches from work areas before flame cutting, flame straightening, air-carbon arc gouging and/or welding operations. This shall be done as directed by the Engineer.
2. Prior to welding the areas to be welded shall be cleaned to bright metal, then preheated to 250°F and maintained at a range of between 250°F minimum and 400°F maximum. The prescribed distance from the weld centerline for base metal temperature control is defined by Section 708.1 par. 2 of the New York State Steel Construction Manual. Base metal preheat and interpass temperature control shall be closely monitored with the use of temperature-indicating crayons or some other elevated temperature monitoring device.
3. Flame cutting, air-carbon arc gouging and welding shall be performed by welding personnel in possession of a current New York State DOT Field Welder Certification. (It should be noted that not all certified personnel are qualified to weld in the overhead (4G or 4F) position).
4. Field welding shall be done utilizing only low hydrogen electrodes, AWS classification F/018, or for weather grades F8048-C3. Electrodes shall be conditioned, stored and used in accordance with the provisions of Section/of the New York State Steel Construction Manual.
5. All welding shall be performed in compliance with an approved Welding Procedure Specification (WPS)
6. Nondestructive Testing (NDT) shall be performed in accordance with the application section(s) of the New York State Steel Construction Manual.
7. Welded repairs which are made in tension areas of main members shall be ultrasonically examined (UT) by personnel from the New York State DOT Metals Engineering Unit. The Metals Engineering Unit shall be notified at least five (5) working days in advance to facilitate the scheduling of testing. Contact Jack Wheeler, P.E. at (518)457-4525 to arrange for scheduling.
8. Repaired areas shall be repainted using a paint system which is approved by the Engineer.

## **STEEL SUPERSTRUCTURE REPAIRS**

### **Stiffener/Connection Plate Repair**

#### **Bent Stiffener**

1. See General Notes
2. After paint removal around the stiffener/connection plate, magnetic particle or dye penetration exams shall be performed to determine if the attaching fillet welds were damaged.
3. Any welds found to be cracked shall have the cracked portion of the weld removed by grinding plus an additional two inches unless the crack ends at the edge of the plate. Magnetic particle or dye penetrant testing shall be used to ensure complete removal of the crack.
4. Using any substantial welded member, place a hydraulic jack and wooden timber, minimum 4x4, in place against the bent portion of the stiffener as shown in sketch 1. Bring the bent portion of the steel up to 1,100 to 1,150\* F as quickly as possible using a heating torch. Care should be taken during the heating process not to exceed 1200\* F. Use temp sticks to verify temperature.
5. After the steel has been heated, use pressure from the jack to move the bent portion back as close as possible to its original position.
6. If any welds were determined to be cracked they may be repaired at this time. Fillet welds will be welded using WPS-1. All welding shall be performed by New York State certified welders that are qualified for the process and position of welding to be performed.

WELDING PROCEDURE SPECIFICATION

Material specification A-36  
 Welding process SMAW  
 Manual, semiautomatic or automatic MANUAL  
 Position of welding VERTICAL & HORIZONTAL  
 Filler metal specification A5.1  
 AWS Filler metal classification E-7018  
 Electrode and manufacturer ANY MADE IN USA  
 Flux and manufacturer N/A  
 Shielding gas N/A Dew Point N/A Flow Rate N/A  
 Single or multiple pass MULTIPLE  
 Single or multiple arc SINGLE  
 Welding current DC  
 Polarity POSITIVE  
 Welding progression VERTICAL UP  
 Root treatment CLEAN PER SECT. 603 OF NYS SCM  
 Preheat and interpass temperature 250°F MIN  
 Postheat treatment NONE

WELDING PROCEDURE

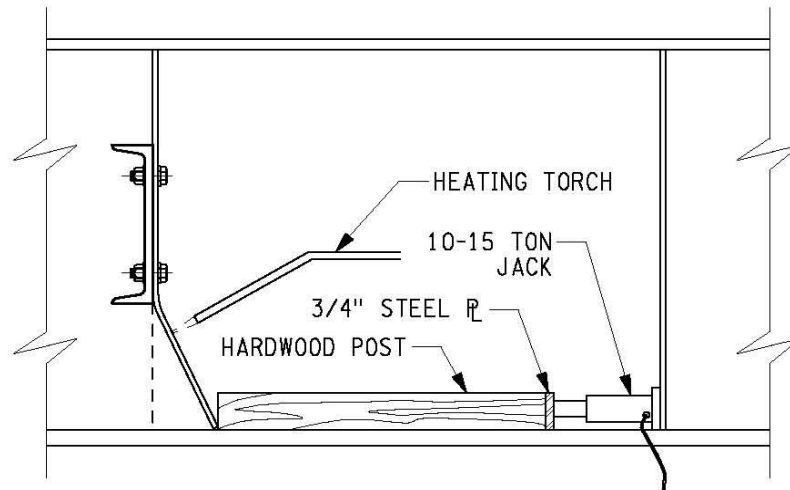
Pass no.	Electrode size	Welding parameters		Travel speed	Joint detail
		Amperes	Volts		
ALL	5/32"	130-210		37 ipm	<p>Sequence of weld passes shall be shown diagrammatically</p>

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in Section 8A.

Procedure no. WPS-1 Fabricator or Erector \_\_\_\_\_

Revision no. \_\_\_\_\_ Authorized by \_\_\_\_\_

Date \_\_\_\_\_



NOTE: BOLTED MEMBER MAY OR MAY NOT  
BE PRESENT.

### CONNECTION PLATE - STIFFENER





## REPAIR PROCEDURE

### Crack in Fillet Weld between Stiffener & Top Flange

This repair is for a crack that may be found in the overhead fillet weld between the stiffener plate and the girder top flange.

1. Paint shall be removed at least 6 inches from areas of work prior to flame cutting, flame straightening, air-carbon arc gouging, and/or welding operations.
2. Examine the weld area using Magnetic Particle (MT) or Dye Penetrant (PT) Testing as outlined in Section 18 or 19 of the New York State Steel Construction Manual (SCM) to determine the limits of the cracked fillet weld.
3. Remove the cracked fillet weld by grinding. Exercise care during removal to avoid damaging the top flange or the stiffener.
4. Re-examine the weld using MT or PT to ensure that the crack has been completely removed. If a crack-like indication is found, further grinding and testing will be required. (If, upon further examination it is discovered that the crack has propagated into the flange and/or the stiffener, please contact the Metals Engineering Unit for a recommended repair procedure).
5. Replace the removed fillet weld using Welding Procedure Specification WPS - Fillet Weld Stiffener/Top Flange. All welding shall be done using New York State Field Welders' certified to weld fillets in the overhead (4F) position. Welding shall be done using AWS Classification E7018\* electrodes which shall be stored and used in accordance with the provisions of Section 7 of the SCM. All welding shall be performed in accordance with an approved Welding Procedure Specification.
6. Re-examine the completed repair visually to ensure that no cracking of the repair weld has occurred. This should be done after the weld area has returned to ambient temperature.
7. Repaint the repair area in accordance with an approved maintenance procedure as directed by the Engineer.

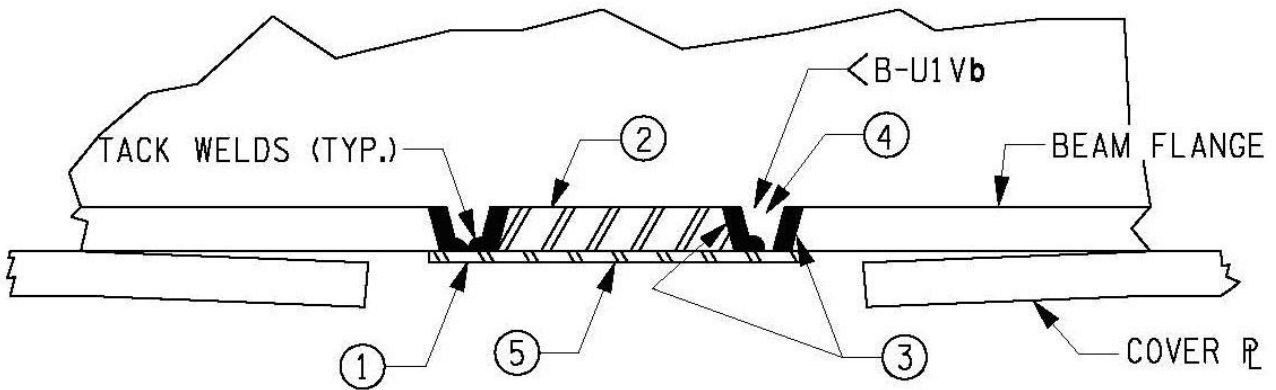
\* Base metal that is A709 grade 50W (A588) 'weathering' grade material shall employ SMAW electrodes with AWS Classification E8018-C3

### WELDING PROCEDURE SPECIFICATION

MATERIAL SPECIFICATION      ASTM A709 (A36 / A572) (A588\*)  
WELDING PROCESS                      SMAW  
MANUAL, SEMI-AUTOMATIC or AUTOMATIC      MANUAL  
POSITION OF WELDING                      OVERHEAD (4F);  
FILLER METAL SPECIFICATION – AWS      A 5.1; A5.5\*  
FILLER METAL CLASSIFICATION              E 7018; E8018-C3\*  
ELECTRODE and MANUFACTURER              ANY MFG. IN U.S.A.  
FLUX AND MANUFACTURER                      N/A  
SHIELDING GAS      N/A              DEW POINT      N/A              FLOW RATE      N/A  
SINGLE or MULTIPLE PASS                      MULTIPLE  
SINGLE or MULTIPLE ARC                      N/A  
WELDING CURRENT                      DIRECT CURRENT (DC)  
POLARITY                      ELECTRODE POSITIVE (+)  
WELDING PROGRESSION                      N/A  
ROOT TREATMENT      CLEAN TO BRIGHT METAL, FREE OF LOOSE SCALE, RUST, ETC.  
PREHEAT and INTERPASS TEMPERATURE      250° F MIN. (MAINTAIN THROUGH COMPLETION)  
POSTWELD TREATMENT                      N/A

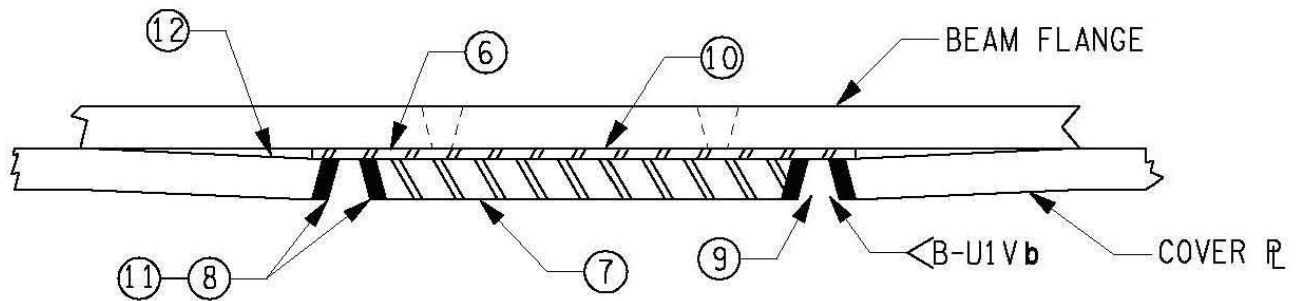
PASS NO.	ELECTRODE SIZE	WELDING PARAMETERS		TRAVEL SPEED	JOINT DETAIL
		AMPERES	VOLTS		
ALL	1/8"	90 - 150			<p style="text-align: center;"><u>WEB STIFFENER / TOP FLANGE</u></p>
ALL	5/32"	130 - 200			

PROCEDURE NO.    WPS – FILLET WELD – STIFFENER / TOP FLANGE



## FLANGE REPAIR

- ① INSTALL A 3/16" BACKING PLATE. TACK WELD THE PLATE INSIDE THE JOINT WHICH WILL BE WELDED.
- ② INSTALL THE REPLACEMENT PORTION OF FLANGE BEING CAREFUL OF PROPER ALIGNMENT FOR THE JOINT TO BE WELDED.
- ③ INSTALL THREE INCH LONG RUN-OFF TABS, THE SAME SHAPE AS THE JOINT TO BE WELDED, ON WHICH TO START AND STOP THE WELDS.
- ④ PREHEAT AND COMPLETE THE FLANGE PATCH WELDING.
- ⑤ REMOVE THE BACKING PLATE AND RUN-OFF TABS AND GRIND THE REPAIRED AREA FLUSH AND SMOOTH.

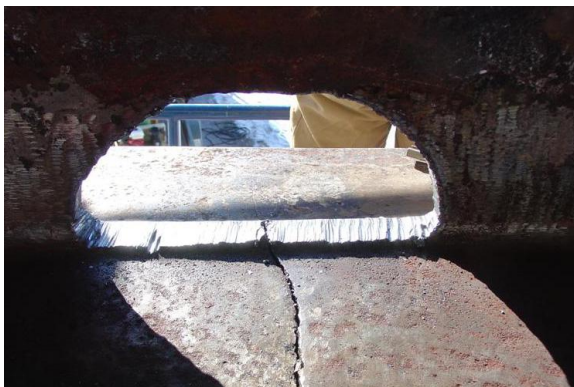


## COVER PL REPAIR

- ⑥ INSTALL A 3/16" BACKING PLATE AS DESCRIBED IN ① ABOVE. THIS PLATE WILL NOT BE REMOVED. REMOVE THE WEDGES AT THIS POINT.
- ⑦ INSTALL THE REPLACEMENT PORTION OF COVER PLATE AS DESCRIBED IN ② ABOVE.
- ⑧ INSTALL RUN-OFF TABS AS DESCRIBED IN ③ ABOVE.
- ⑨ PREHEAT AND COMPLETE THE COVER PLATE PATCH WELDING.
- ⑩ TRIM THE BACKING PLATE BACK TO THE EDGE OF THE BEAM FLANGE. BE CAREFUL AIR-ARC GOUGING AND GRINDING.
- ⑪ REMOVE THE RUN-OFF TABS AND GRIND THE REPAIRED AREA FLUSH AND SMOOTH.
- ⑫ REPLACE THE COVER PLATE AND BEAM FLANGE FILLET WELD, WHICH WAS REMOVED. WHEN WELDING OVER THE EDGE OF THE BACKING PLATE, THE FILLET WELD SIZE SHALL BE INCREASED BY AT LEAST 3/16".

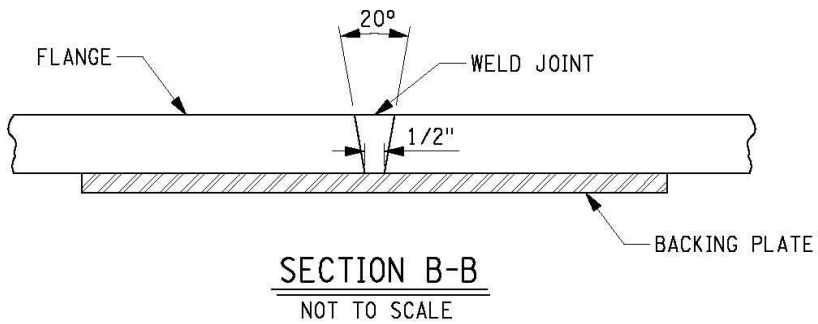
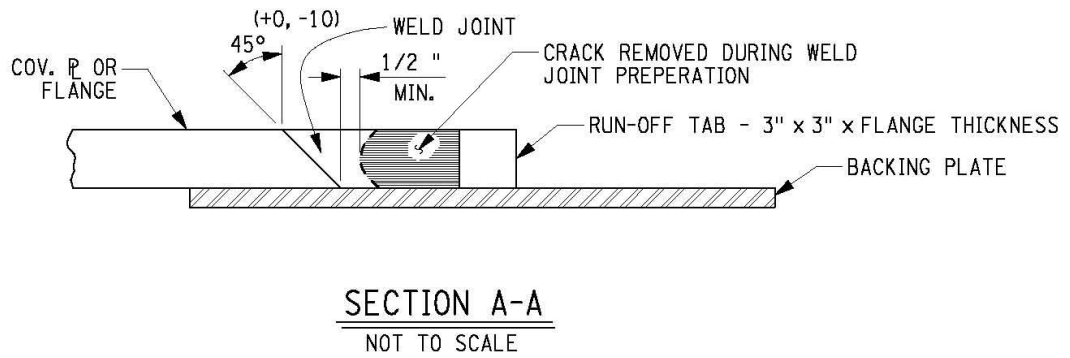
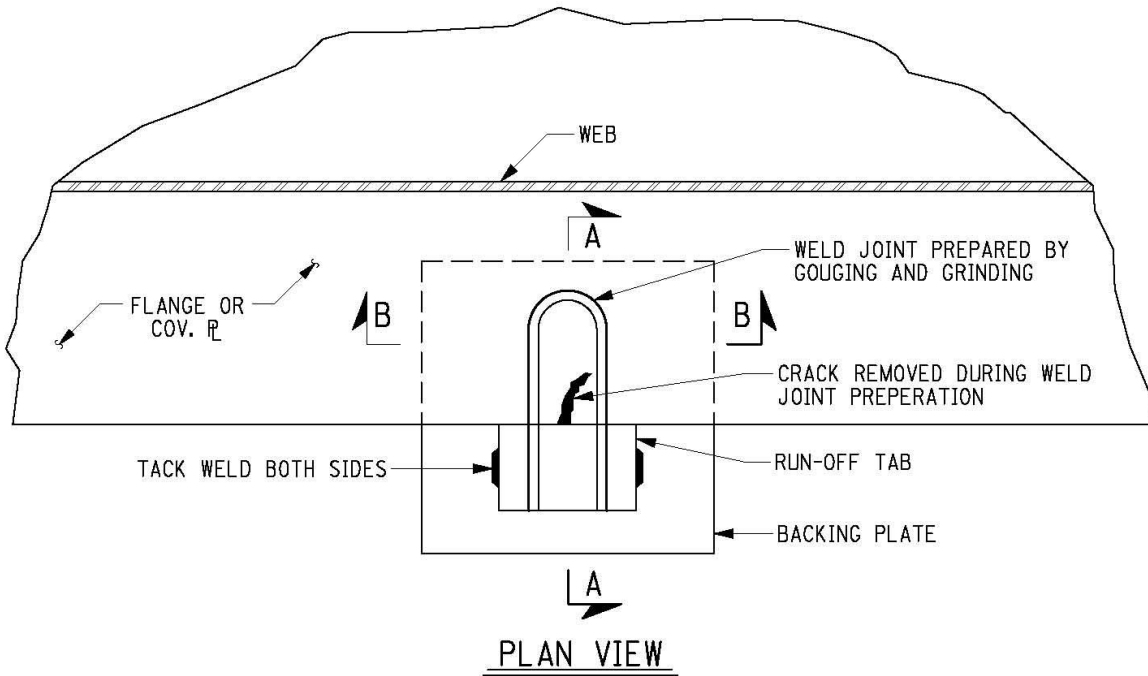
## Cracked Beam Repair Procedure

1. The beam must be straight and the crack edges must be aligned before repairing the crack.
2. Tack weld the run-off tab to the backing plate and clamp this assembly to the flange at the crack location.
3. Remove the crack and prepare the weld joint by air carbon arc gouging followed by grinding.
4. Welding shall be done with stringer beads as described in the general notes.
5. After welding, remove the backing plate/run-off tab assembly and grind the repaired area flush and smooth.





# TYPICAL CRACKED BEAM FLANGE REPAIR





## Impact Damage Repair - Bottom Flange

1. See General Notes
2. Any damage that extends less than  $\frac{1}{4}$ " into the base metal of the structure may be repaired by grinding. The base metal shall be made smooth and flush and shall be faired-out to a slope no less than 1 in 10 by grinding.
3. Dents and gouges greater than  $\frac{1}{4}$ " deep shall be repaired by welding using the SMAW process.
4. If there is a crack present at the impact locations, it must be fully ground out before further repairs are attempted. Grind the crack location and then test by either magnetic particle testing or by dye penetrant. If the crack has not been fully removed, more grinding and testing will be required. Once the crack is fully removed, continue with the repair welding.
5. For impacts which only affect the underside of the bottom flange, use Welding Procedure WP-2 with a run off tab at the edge of the flange.
6. Once welding is complete, remove the run off tab or back up plate, grind the area smooth to blend in with the adjoining base metal. Ultrasonic Testing must be performed at the repair area before painting. Call (518) 485-5059 or (518)457-4525 to schedule testing.

WELDING PROCEDURE SPECIFICATION

Material specification ASTM A-7

Welding process SHIELDED METAL ARC WELDING

Manual, semiautomatic or automatic MANUAL

Position of welding ALL POSITION

Filler metal specification AWS A 5.1

Filler metal classification E 7018

Electrode and manufacturer ANY MADE IN U.S.A.

Flux and manufacturer N/A

Shielding gas N/A Dew point N/A Flow rate N/A

Single or multiple pass MULTIPLE

Single or multiple arc SINGLE

Welding current DIRECT

Polarity REVERSE (DC +)

Welding progression STRINGER BEADS

Root treatment CLEAN TO BRIGHT METAL

Preheat and interpass temperature 250 F MIN.

Postheat treatment NATURAL COOLING

WELDING PROCEDURE

Pass no.	Electrode size	Welding parameters		Travel speed	Joint detail
		Amperes	Volts		
1	1/8"	90-160	-	4-8 ipm	

Sequence of weld passes shall be shown diagrammatically

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in Section 8A.

Procedure no. WPS- 2 Fabricator or Erector \_\_\_\_\_

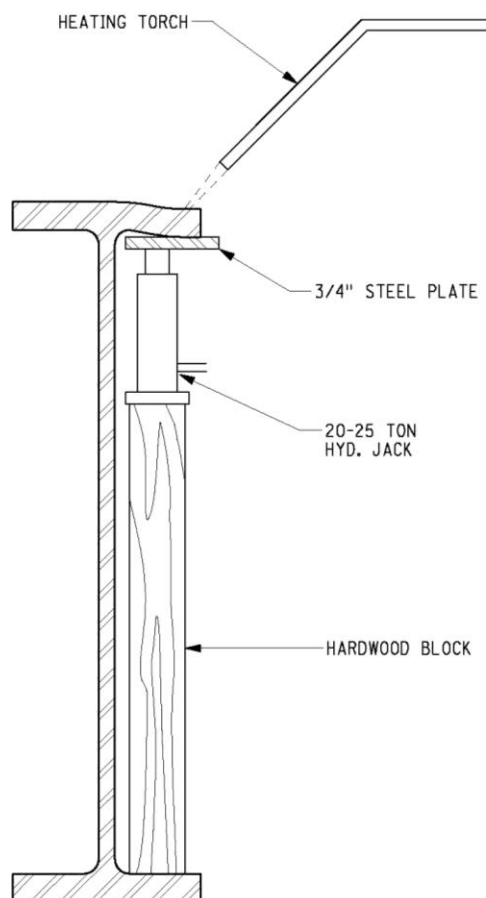
Revision no. \_\_\_\_\_ Authorized by \_\_\_\_\_

Date \_\_\_\_\_

\* The cavity shall be boat shaped with a minimum radius of 1/4".

## Flange Repair, Damage Due To Deck Removal

1. See General Notes
2. Install the jacking device shown in sketch SK-1.
3. Heat the damaged areas to between 1050 and 1100 degrees F. Bring the steel up to temperature as quickly as possible using a heating torch with appropriate tip. Do not exceed 1200°F. Use temperature indicating crayons or a pyrometer to closely monitor the temperature of the steel during the heating process.
4. Once the entire damaged area is up to temperature, use the jack to bring the upper flange as close as possible to its original position.
5. Leave the jacking device in place until the steel cools to below 600°F.
6. Once the steel cools remove the jacking device.
7. Perform magnetic particle exam in the damaged area to insure that no cracks have formed in the repair area.



## HEAT STRAIGHTENING

### Repair for Impact Damage, General Superstructure Repair

1. A visual inspection shall be performed on the impact areas and on the connection palates at both ends of the diaphragms. In addition, both side of the web on either side of the point of impact shall be inspected. Particular attention shall be paid to areas where the paint has flaked and or rust is apparent. It will be necessary to remove paint in these areas prior to inspection. If cracks are found, the metals engineering unit shall be notified prior to repairing.
2. Remove the bolts from both ends of the damaged diaphragm at the point of impact. The bolts may be removed by unbolting or, at the fascia end of the diaphragm by flame cutting on the connection plate side of the joint. Remove and dispose of the diaphragm.
3. Remove the damaged diaphragm connection plate from the fascia girder by air-arc gouging or flame cutting. If it is elected to flame cut the connection plate, the cut line shall be 1/8" from the girder web. All remaining weld and connection plate material shall be removed by grinding flush to the girder web base metal. If a crack is found to extend into the web, it must be repaired by gouging and welding. Contact Metals Engineering Unit for repair details.
4. Install a minimum of two hardwood timbers in the bay adjacent to the damaged girder as shown on the Sketch Sheet SK-1. The timers should be spaced about two feet apart, approximately opposite the point of impact.
5. Install the jacking device as shown on Sketch Sheet SK-1 with the ram end at the point of impact and with the jacking end centered between the timbers. Load the jacks until substantial resistance is felt. This is to produce a load that is sufficient to restrain the piece during the heat-shrink straightening, but would not produce a stress greater than 20 ksi under any condition.
6. Using two torches at the same pattern, one directed at the top of the bottom flange and one directed up from below the girder, heat within the patterns described in article 1501 .8 of the SCM and as shown on Sketch Sheet SK-3. Heat to bring the steel up to a temperature of between 1050 and 1150 degrees as quickly as possible. The maximum temperature shall be carefully controlled, using tempil sticks. Do not overheat the steel.
7. The first heat pattern shall be applied to the convex side of the bent member at the point of impact. Compressed air can be used to cool the steel after it has dropped to a temperature of 600° F. However it is generally unnecessary to artificially cool the steel in bridge repairs.
8. As the work progresses, pressure should be maintained on the jacks. This is not a restraint load and not a heat-forging load. Additional pressure shall not be applied to the jacks while the steel is being heated or immediately after maximum heat has been attained.
9. The structural steel will move in the desired direction as the steel cools. It is

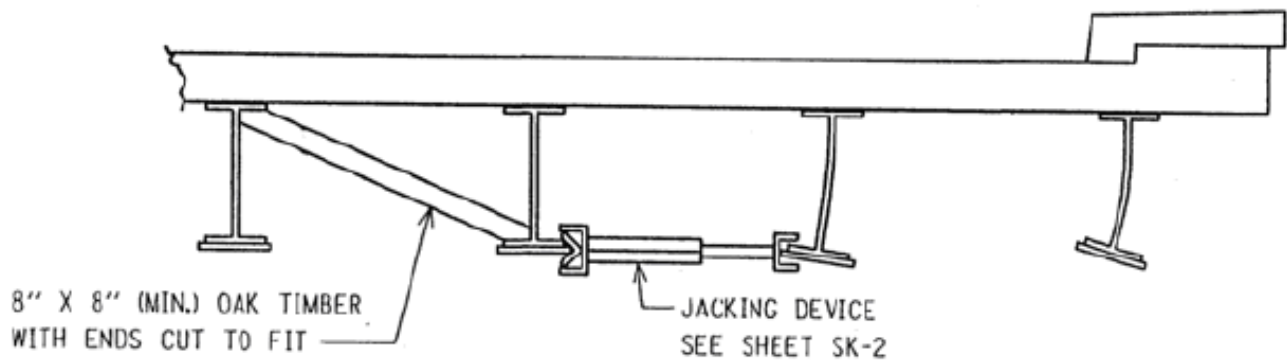
during this cooling-deformation phase that the pressure should be maintained on the jacks. Heating patterns can be heated in any order provided that surrounding areas have had a chance to cool to a temperature less than 100°F. Heating Steel that is already hot does not produce effective results. The initial heating patterns may be spaced at about 18 inches center to center so that additional patterns may be placed between them as required. Patterns may overlap as work progresses and as a result, some steel may be heated more than once at a specific location. This will not damage the steel if the provisions of the Steel Construction Manual are followed.

10. Straightening to a tolerance of about ¼ inch per 10 feet of measured length is generally considered acceptable. Localized dents are almost impossible to repair in flanges. Localized sweeps are generally left unrepaired. Dents at points of impact are best repaired by welding.
11. After straightening and before welding, the impacted area shall have Magnetic Particle Inspection performed by personnel trained by the Metals Engineering Unit of the Main Office, Structures Division. Any cracks discovered will need to be repaired by welding, as directed by the Metals Engineering Unit.
12. Prepare a new diaphragm and connection plate of compatible material and of the same dimensions as the existing diaphragm and plates which were removed. Do not drill the bolt holes at this time.
13. Weld the new connection plate to the web with a 5/16 inch vertical fillet weld on each side of the plate. (Weld progression shall be from bottom to top) This shall be done in accordance with a Welding Procedure Specification (WPS) submitted to or supplied by the Metals Engineering Unit.
14. Field drill new bolt holes in the new diaphragm and new connection plate. Drill the holes in the new connection plate with the diaphragm in place to ensure a good fit up.
15. Install 7/8" diameter ASTM A 325 bolts to connect the diaphragm to the connection plate. Use two washers, one under the head and one under the nut.
16. Tighten the bolts 1/3 turn beyond snug tight. Snug tight is defined as the full effort of a man using an ordinary spud wrench.
17. The gouges at the impact location shall be repaired by grinding or welding. Grind the impact location to remove the gouged metal. After grinding, magnetic particle testing shall be performed to ensure that there are no cracks present. Any cracks discovered will require more grinding until the crack is fully removed. Cracks which extend into the flange to cover plate fillet weld will require a more extensive repair procedure, which will be provided by the Metals Engineering Unit if necessary.
18. Once the impacted steel and any cracks are fully removed, dents and notches exceeding ¼ inch in the affected area shall be repaired by welding. Welding must be performed by a certified welder in accordance with a Welding Procedure Specification which has been submitted to and approved by the Metal Engineering

Unit. Weld to restore the full cross section of the cover plate and flange and grind any excess material flush and smooth with the adjoining base metal of the cover plate.

19. After the repair welding is complete, the areas must be Ultrasonic Tested (UT) to ensure the quality of the weld. This testing will be performed by personnel from the Metals engineering Unit. Contact the MEU five full working days in advance to schedule testing.

20. After all repairs and required testing has successfully been completed, the repaired areas shall be repainted as directed by the Engineer.

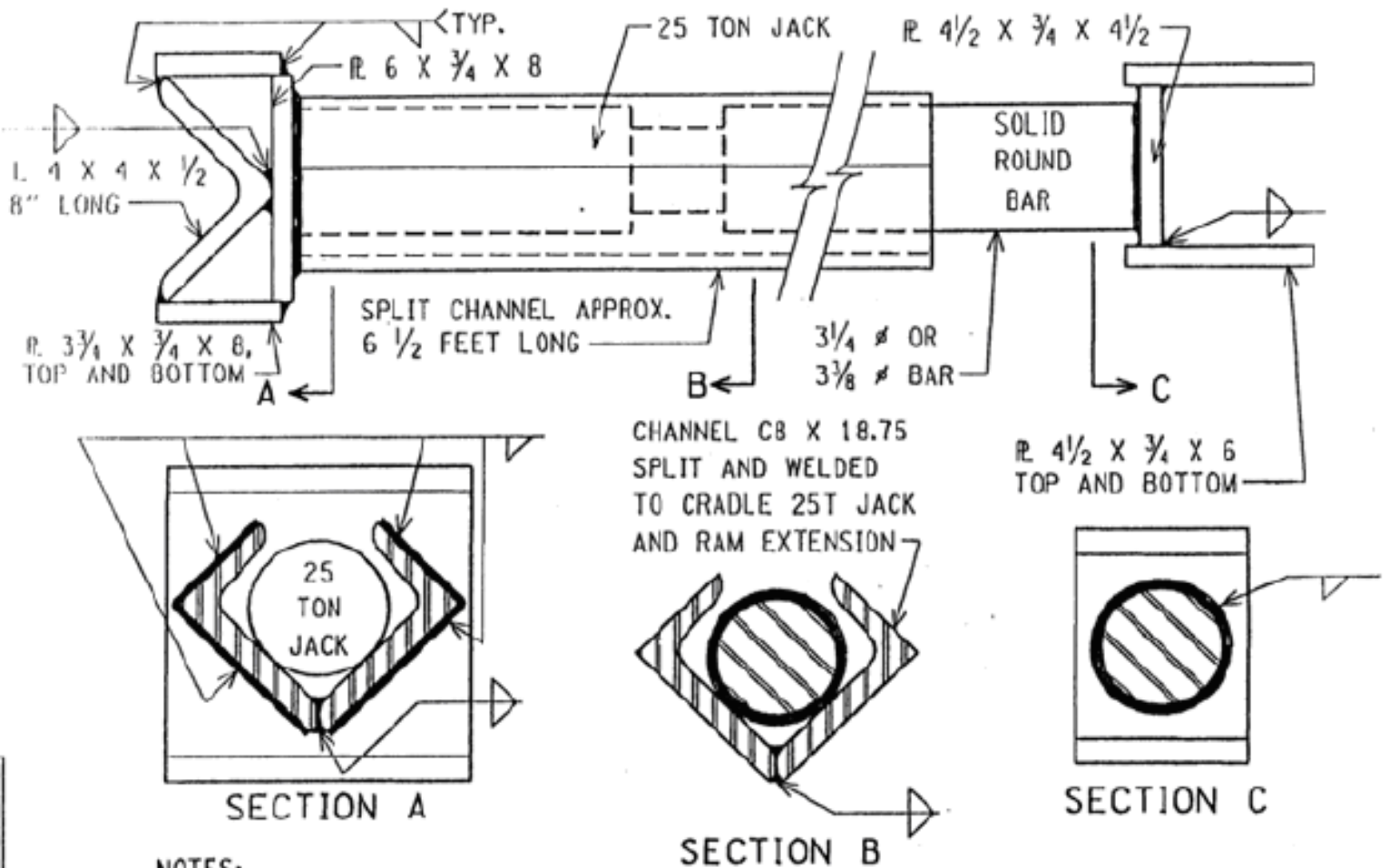


**NOTE:**

THE NUMBER OF JACKING DEVICES  
REQUIRED SHALL BE AS DETERMINED  
BY THE CONTRACTOR.

**TYPICAL ARRANGEMENT OF JACKING DEVICE  
BIN**

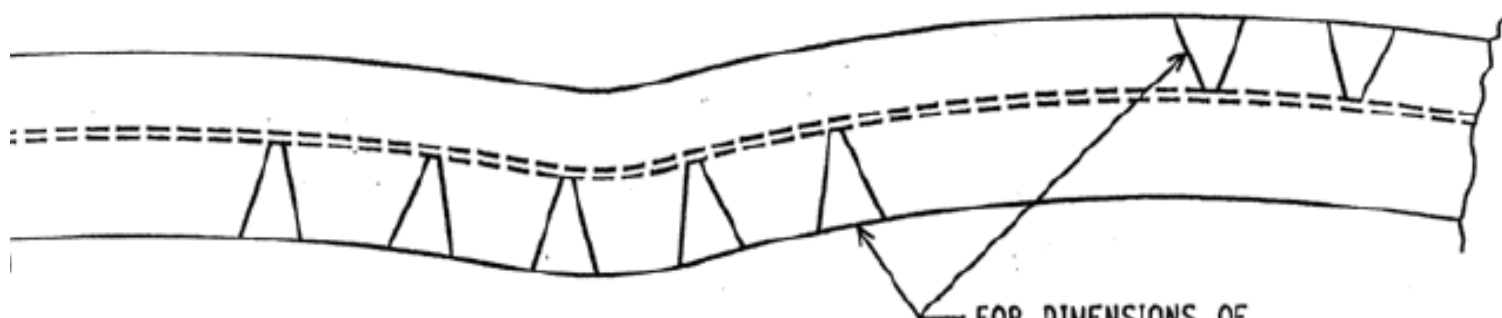
**SK-1**



NOTES:  
 ALL FILLET WELDS SHALL BE 5/16" MINIMUM UNLESS OTHERWISE SPECIFIED OR DETAILED

## JACKING DEVICE SK-2

AFTER THE MAIN DEFORMATION HAS BEEN STRAIGHTENED, CHECK THE GIRDER FOR REVERSE CURVATURE AND IF APPARENT, CORRECT THE CURVATURE BY THE HEAT SHRINK METHOD



**NOTE:**

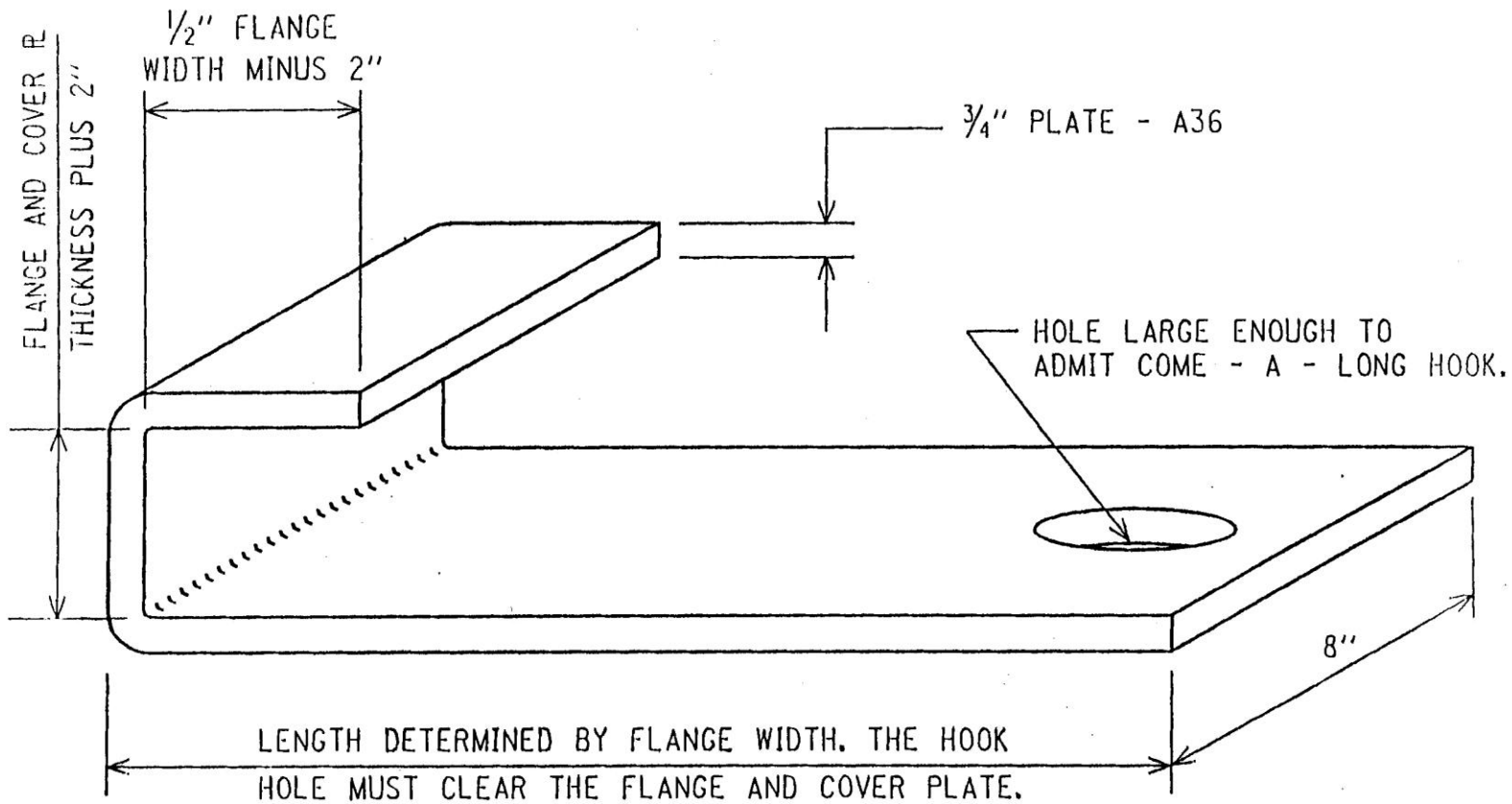
THE NUMBER AND LOCATIONS OF HEAT PATTERNS SHALL BE DETERMINED BY THE CONTRACTOR

FOR DIMENSIONS OF THE PATTERNS, SEE THE NEW YORK STATE STEEL CONSTRUCTION MANUAL, SECTION 15

## TYPICAL HEATING PATTERNS

**SK-3**

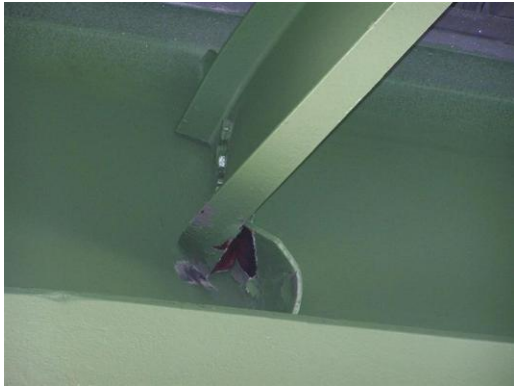




**NOTE:**

HOOKS MAY BE HEATED AND BENT TO THE SHAPE SHOWN OR THEY MAY BE FABRICATED FROM THREE SEPARATE PLATES. IF FABRICATED, THE CORNER WELDS SHALL BE COMPLETE PENETRATION GROOVE WELDS.

**FABRICATED HOOKS**



## REPAIR PROCEDURE

### Heat Straightening - Girder Bottom Flange

1. Remove paint for six inches around any area that will be cut, heated or welded using an approved paint removal procedure.
2. Install two 8 x 8 hardwood timbers in the bay adjacent to the damaged girder as shown in Sketch SK-I . The timbers should be spaced about two feet apart, approximately opposite the point of impact. Do not remove the damaged connection plate at this time.
3. Install at least two jacks as shown on Sketch SK-I.. Install one on each side of the impact point with about three feet total spacing between the jacks.
4. Load the jacks to a total load of five tons (2.5 tons per jack). This is to produce a load that is sufficient to restrain the girder during heat straightening but not enough to cause mechanical straightening.
5. Using one torch, heat within the vee patterns shown on Sketch SK-3 to bring the steel up to a temperature of between 1050 and 1220 degrees F., as quickly as possible. The patterns should be heated starting at the apex of the triangle and moving outwards in one continuous S-shaped pattern. (See Note below)
6. The first heat pattern should be applied to the convex side of the bent member at the point of impact. Compressed air may be used to accelerate the cooling of steel after it has dropped to a temperature of 600 degrees F.
7. As the steel cools, maintain the pressure obtained in Step 4 on the jacks.
8. The structural steel will move in the desired direction as the steel cools and contracts. It is during this cooling/deformation phase that the pressure should be maintained on the jacks. Heating patterns may be heated in any order, provided the surrounding areas have had a chance to cool to a temperature below 100 degrees F. Heating steel that is already hot does not produce effective results.

#### NOTE:

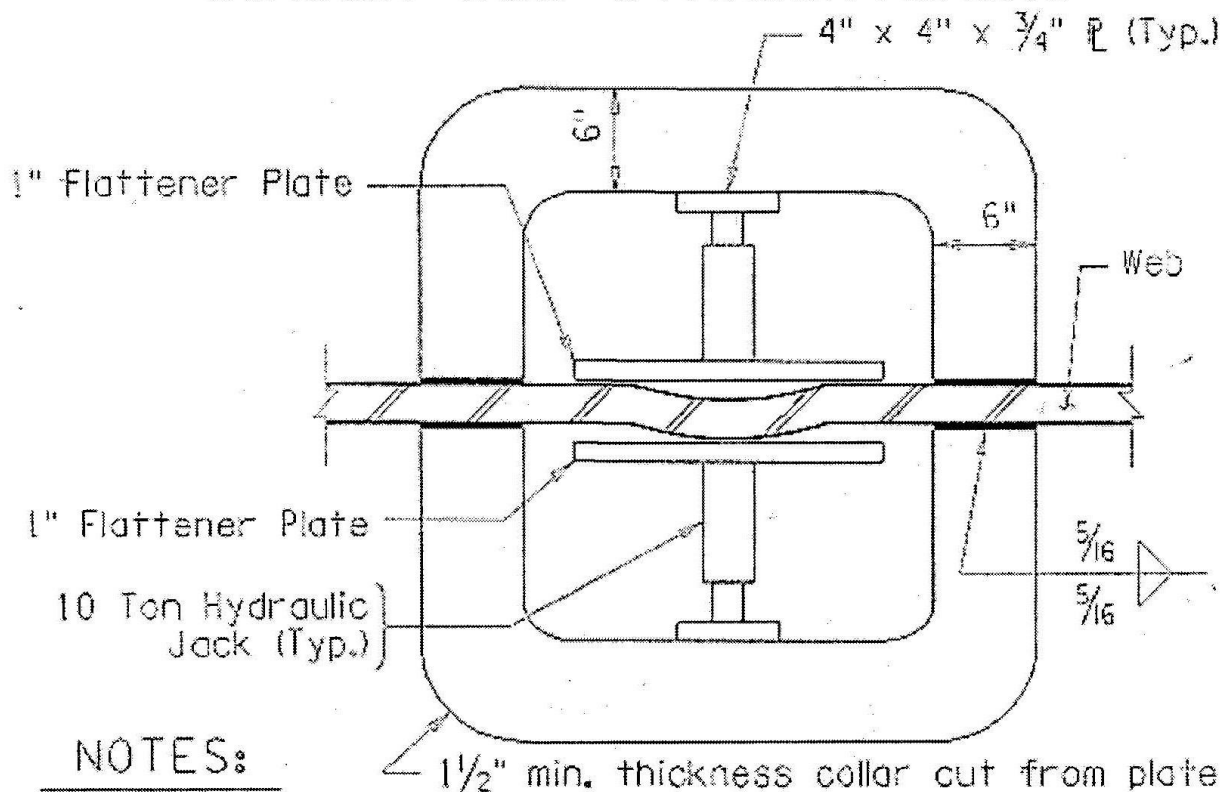
The initial heating patterns may be spaced approximately 18 inches center-to-center so that additional patterns may be placed between them as required. Patterns may overlap as the work progresses, and as a result, some steel may be heated more than once in a specific location. This will not damage the steel, if the provisions of the NYS Steel Construction Manual (SCM) are followed. Straightening to a tolerance of approx. 1/4 inch in 10 feet of measured (chord) length is generally acceptable. Localized sweeps are generally left unrepaired. Dents at points of impact greater than 3/8 inch are best repaired by welding. If repairs are needed, contact the DCES for a repair procedure. DO NOT exceed 1220 degrees when heating. Closely monitor the heated area with temperature-indicating crayons, to cover the minimum and maximum temperatures specified in this procedure. (e.g. - 100° F; 600° F; 1050° F; 1220° F)





## HEAT STRAIGHTENING REPAIR, STRAIGHTENING GIRDER WEB

### GIRDER WEB STRAIGHTENING



- 1) Heat web deformation to a temperature of between 1050°F and 1200°F as quickly as possible. Temperature shall be checked by temperature indicating crayons.
- 2) Maintain pressure on web deformation as the steel cools.
- 3) Repeat steps 1 & 2 until area is flattened to within the NYSSCM Section 12 tolerance.

#### NOTE:

After the web is straightened to acceptable SCM tolerances remove the collar plates by air-arc gouging or flame cutting so as not to damage the web and grind the area flush and smooth. Check the area for cracks by magnetic particle inspection as described in Section 18 of the NYSSCM. All welding shall be performed in accordance with welding procedure specifications approved by the DCES (Metals Engineering Unit). Minimum preheat and interpass temperature requirements shall apply to all welds, temporary and permanent

## Web Repair Procedures

For section loss

### Bearing Stiffeners

Obtain A-36 or suitable replacement (weathering) angle iron cut to a suitable length to bear on the top and bottom flange and span the distance from the bearing stiffener to the end of the girder. Grind the heel of the angle iron to obtain a tight fit to the web and bearing stiffener. Drill one angle, maintaining the required spacing and edge distance, to use as a template. Clamp this angle and another blank angle to the stiffener and using the predrilled angle as a template drill through the web and second angle. Install A-325 high strength bolts, nuts and washers. Repeat the drilling process on the stiffener side. (See sketch SK-1)

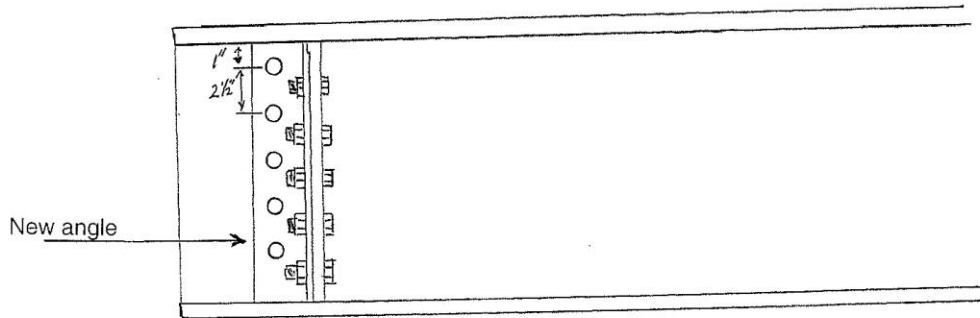
If the distance from the bearing stiffener to the end of the girder is such that stock angle is not available, a larger angle may be cut down to size. The repair shown in sk-2 would also be a consideration.

### Diaphragms

Diaphragms with section loss greater than 40% should be replaced. Bolts may be removed by unbolting or by using an oxyacetylene torch. Care must be used if bolts are cut off. Cutting should be done on the side of the diaphragm that will be replaced. Existing diaphragms can be used as patterns to make new diaphragms.

# Web Wastage Repair Sketch

For  $\frac{3}{4}$  inch bolts, minimum edge distance is 1 inch from the edge or side of material to Center of hole and 2  $\frac{1}{2}$  inches between hole Centers.



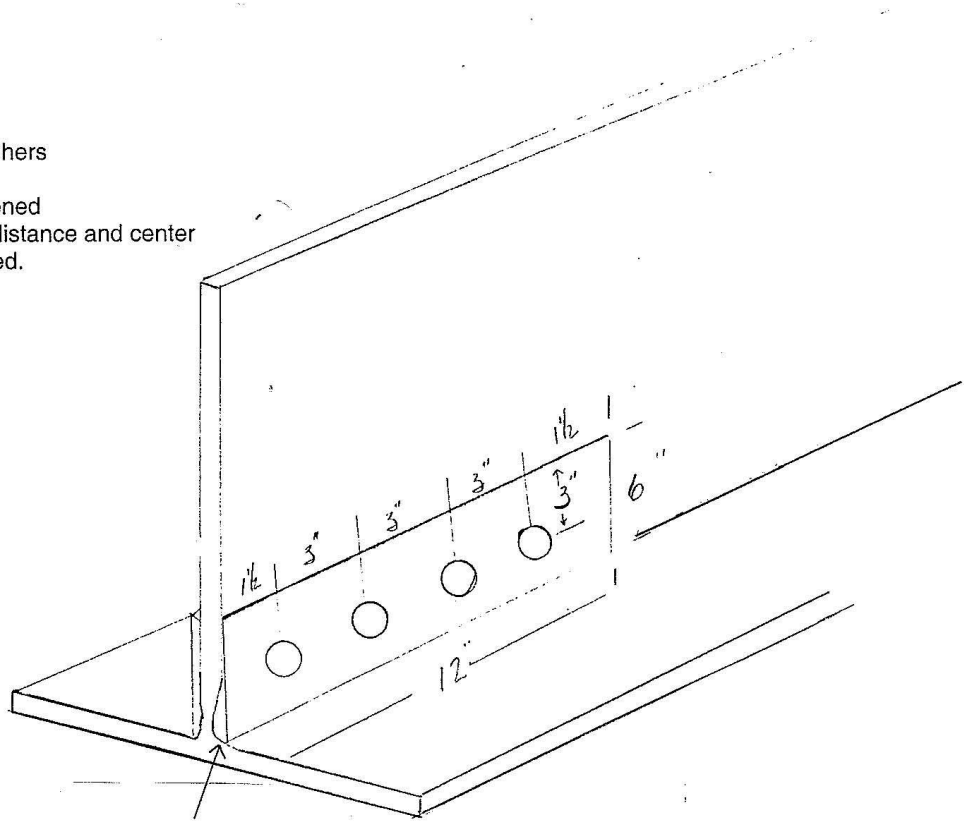
*NOT TO SCALE*

*SK-1*



# Lower Web Wastage Repair Sketch

Notes  
15/16 inch holes  
7/8 inch A325 bolts, nuts & washers  
Plate both sides of web  
Length of plates can be lengthened  
Or shortened as long as edge distance and center  
To center distance is not violated.



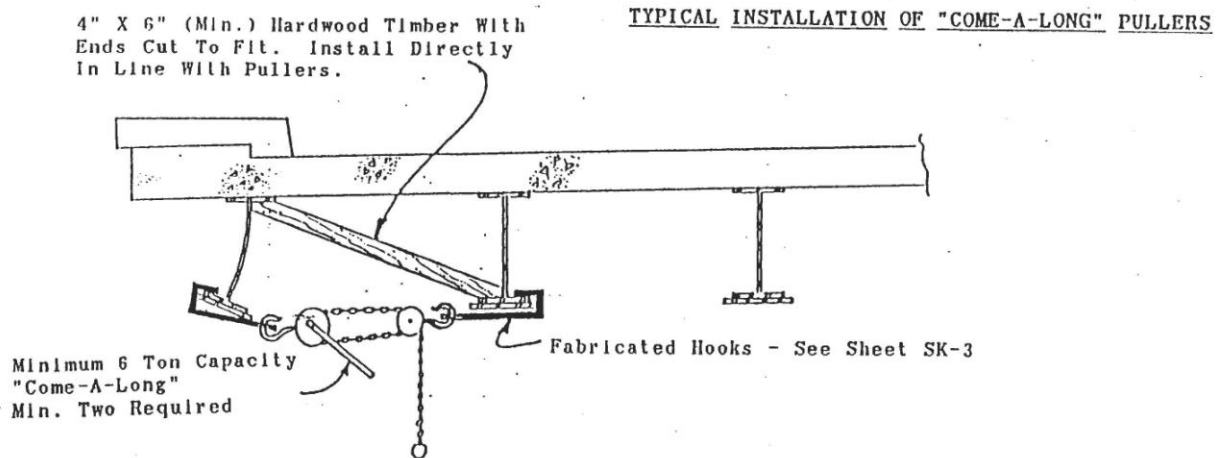
Lower edges of repair plate will require radius to fit web to flange radius

SK-2

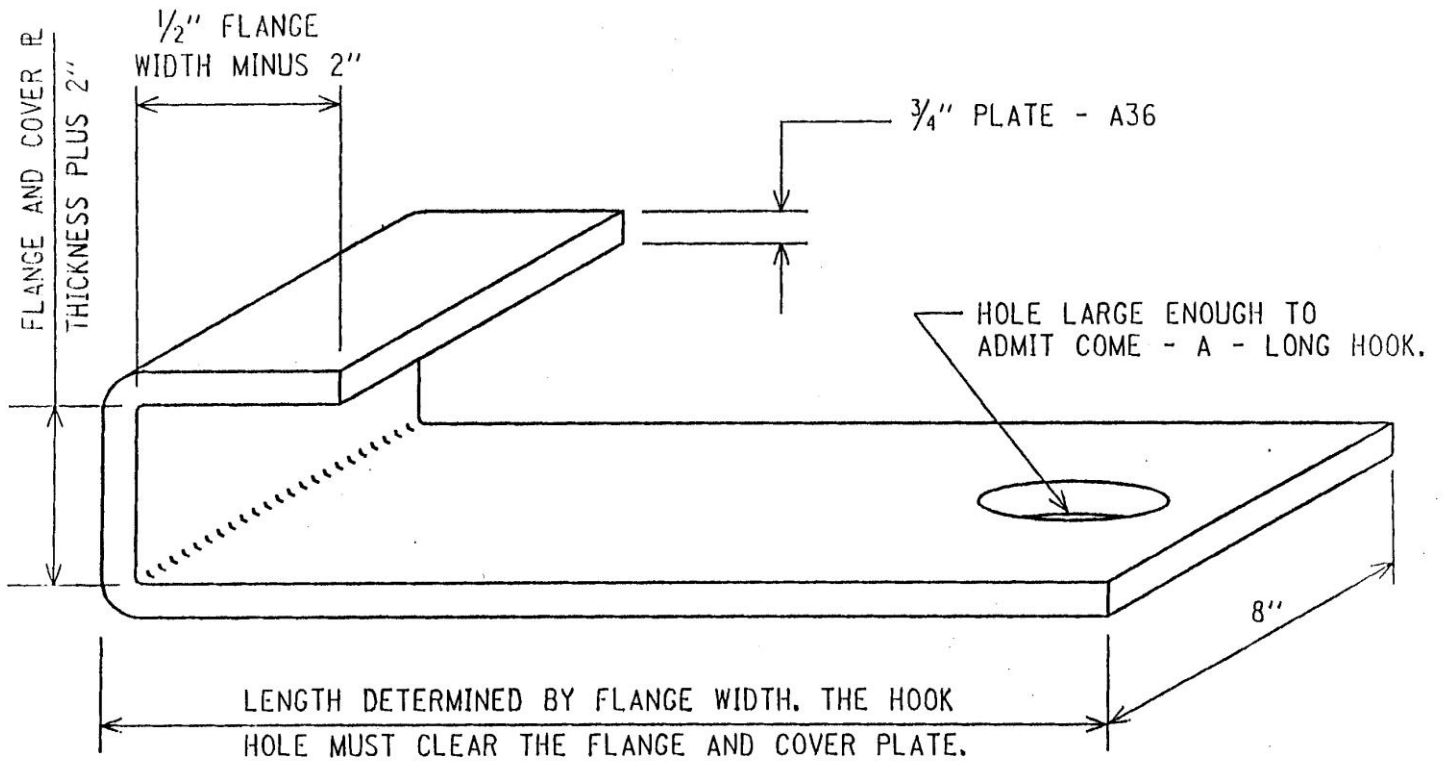
## REPAIR PROCEDURE FOR WASTAGE OF WEB

1. See General Notes
2. Layout cut lines so that the deteriorated material will be removed and an area of substantial material will be left at the weld joint. If the deterioration includes the area within one half inch of the fillet weld at a stiffener/connection plate, remove the stiffener/connection plate.
  - a. Obtain suitable replacement material for the cut out area. Leave the edges of the new material cut square until it is tacked in place. Grind a "U" shaped cavity the mating surfaces of the first side to be welded, and weld in the root pass and hot pass using WPS-1. When the root pass is complete, grind a similar "U" groove on the second side making sure to grind down into the root pass from the first side but not thru the weld. Weld the second side and then complete the first side weld. It may be necessary to alternate side depending on the web thickness to prevent warping.
3. If the connection plate/stiffener was removed, obtain suitable replacement material and reweld using WPS-2. Reconnect any diaphragms that were removed.
4. Notify Metals Engineering that the full penetration welding is complete so that the joint may be ultrasonically tested.

## Typical Jacking Diagrams



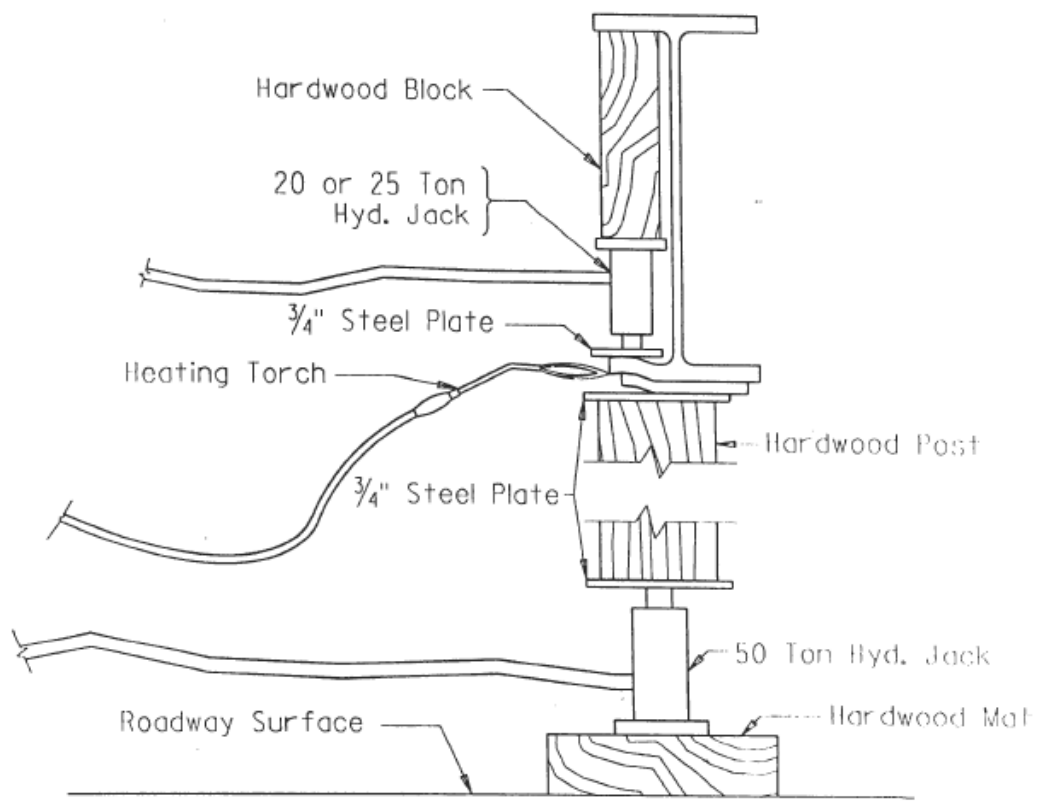
- 1) After the pullers are installed, tighten them until substantial resistance in the pullers is felt.
- 2) Lay out heating patterns along the bottom flange as described in Article 1501.8 of the NYS SCM and begin heating operations.
- 3) As the heated areas cool, maintain slight pressure on the puller so that it does not fall out of position.
- 4) Continue heating and cooling until the beam is straight to a tolerance of 1/4" in ten feet.
- 5) Some heating of the web may be required to achieve straightness and to flatten the web.
- 6) All heat straightening work shall be performed in accordance with Section 15 of the New York State Steel Construction Manual.

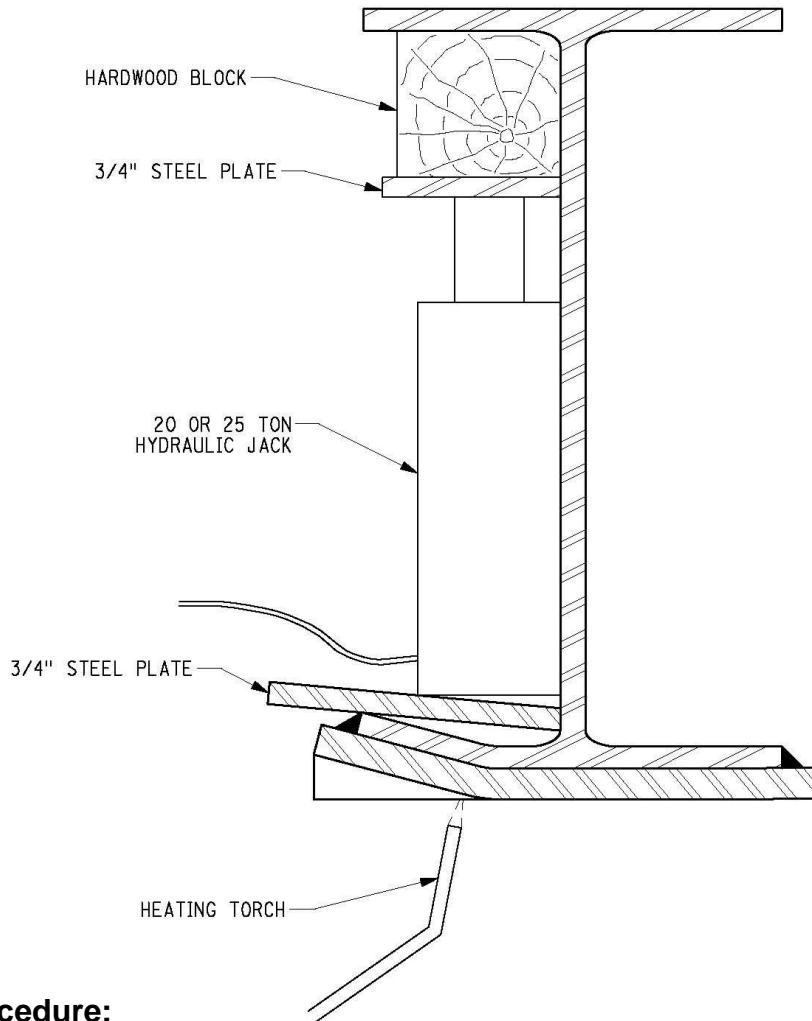


**NOTE:**

HOOKS MAY BE HEATED AND BENT TO THE SHAPE SHOWN OR THEY MAY BE FABRICATED FROM THREE SEPARATE PLATES. IF FABRICATED, THE CORNER WELDS SHALL BE COMPLETE PENETRATION GROOVE WELDS.

**FABRICATED HOOKS**





**Procedure:**

- 1. Position the jacking fixture over the deformed area of flange, as shown.**
- 2. Pump the jack until the bottom flange moves, but no more than  $\frac{1}{4}$  inch.**
- 3. Heat the perimeter of the deformation to a temperature of between 1100 degree and 1200 degree F.**
- 4. Maintain pressure on the jack as the steel cools.**
- 5. Repeat steps 2, 3 and 4 until the deformation is flattened within a  $\frac{1}{2}$  inch tolerance.**

## FLANGE AND COVER PLATE STRAIGHTENING EQUIPMENT

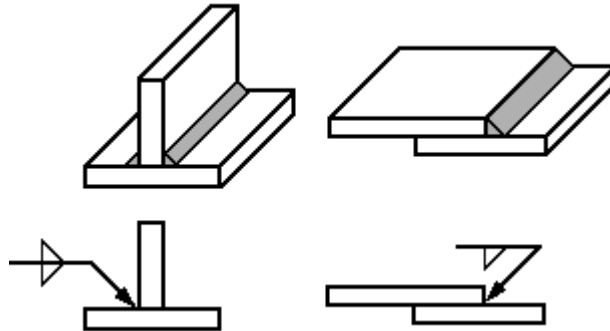
### Tee Section Repair Procedure For Plate Girders

1. Disconnect and remove any diaphragms that will impede the removal of a section of the web and flange. Bolts may be removed by unbolting or by flame cutting. Care should be taken so as not to damage any material that is to be reused.
2. Place temporary supports for the top flange to support the end of the girder during the repair. Supports should be placed so that adequate work area is available for fit up and welding. Supports are to be designed and signed by a P.E.
3. Layout the area of the existing girder to be removed. Flame cut the web and lower flange, leaving enough extra material to allow for preparation of the weld detail. (see sketch 1-A)
4. Secure compatible material and fabricate the web and flange for replacing the web and flange that were previously removed. The upper portion of the web should transition from the horizontal to the vertical cut line with a radius to avoid making a 90° corner. The edges of the horizontal and vertical plates can be left square until tacked in place. Grind the vertical and horizontal weld seams to create a "U" groove on the side to be welded first. Backing bars should also be fabricated for welding the new lower flange to the existing flange.
5. The fillet weld joining the flange to web can either be made prior to placing the replacement section in place or after replacement piece is tacked in place, using WPS 3-A.
6. Preheat the weld joint to 250°F, and weld the first side of the vertical and horizontal joint allowing for cooling periods to control warpage. (using WPS 1-A) When the first side is completed, grind the second side to sound metal and complete the joint. Grind both sides flush with the surrounding base metal taking care not to reduce the base metal thickness.
7. Preheat the flange joint and complete the weld using WPS 2-A, remove the backing strip and grind flush with the base metal. Notify the Metals Engineering Unit at (518) 485-5059 that the repair is complete and is ready for UT testing.
8. The access holes for the lower flange weld may be left unfilled.
9. Remove the temporary supports and paint the repair area using a paint system approved by the Engineer.

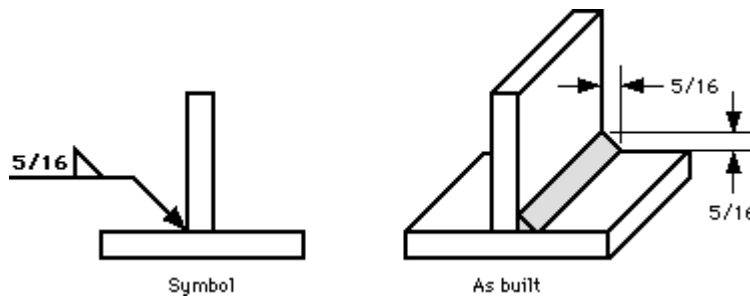
# APPENDIX

## Fillet Welds

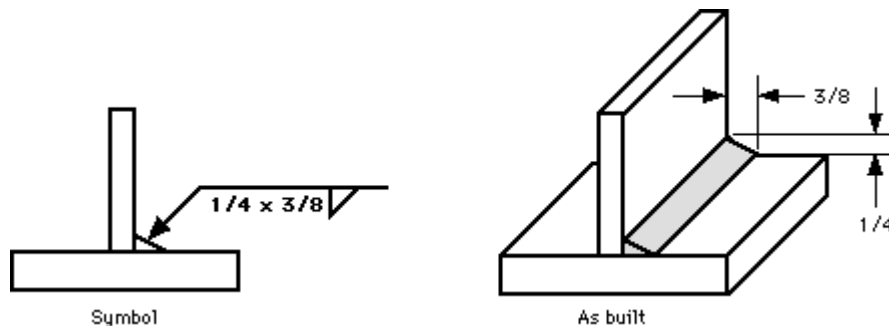
The fillet weld is used to make lap joints, corner joints, and T joints. As its symbol suggests, the fillet weld is roughly triangular in cross-section, although its shape is not always a right triangle or an isosceles triangle. Weld metal is deposited in a corner formed by the fit-up of the two members and penetrates and fuses with the base metal to form the joint. (Note: for the sake of graphical clarity, the drawings below do not show the penetration of the weld metal. Recognize, however, that the degree of penetration is important in determining the quality of the weld.)



The perpendicular leg of the triangle is always drawn on the left side of the symbol, regardless of the orientation of the weld itself. The leg size is written to the left of the weld symbol. If the two legs of the weld are to be the same size, only one dimension is given; if the weld is to have unequal legs (much less common than the equal-legged weld), both dimensions are given and there is an indication on the drawing as to which leg is longer.



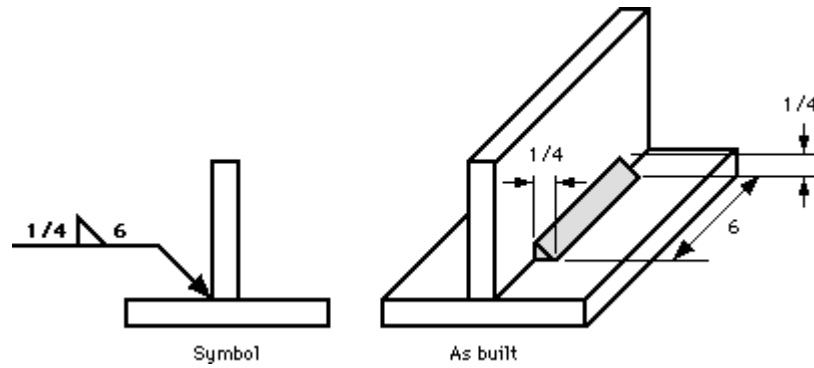
**Equal Leg Fillet Weld**



**Unequal Leg Fillet Weld**

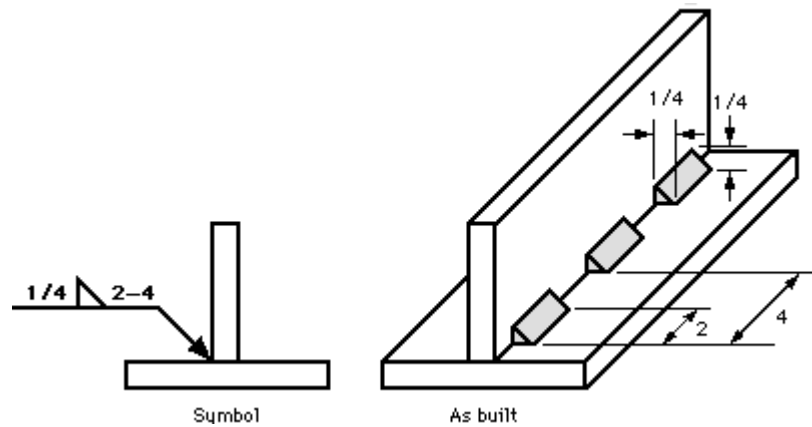
The length of the weld is given to the right of the symbol.





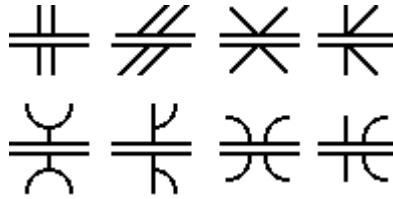
If no length is given, then the weld is to be placed between specified dimension lines (if given) or between those points where an abrupt change in the weld direction would occur (like at the end of the plates in the example above).

For intermittent welds, the length of each portion of the weld and the spacing of the welds are separated by a dash (length first, spacing second) and placed to the right of the fillet weld symbol.



Notice that the spacing, or pitch, is not the clear space between the welds, but the center-to-center (or end-to-end) distance.

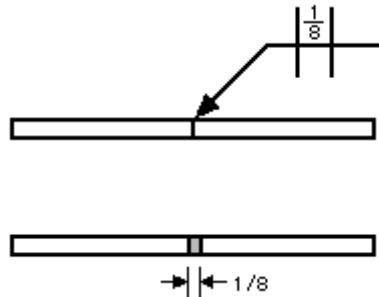
## Groove Welds



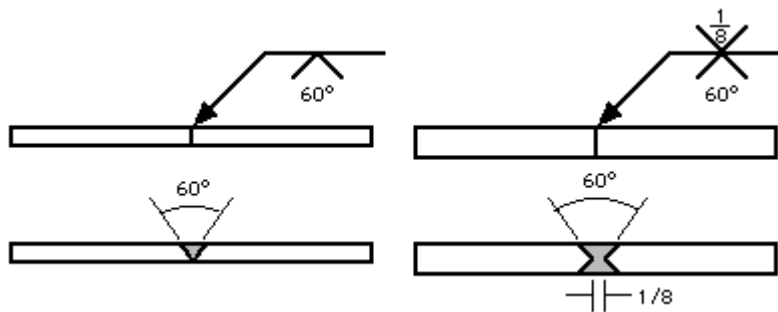
The **groove weld** is commonly used to make edge-to-edge joints, although it is also often used in corner joints, T joints, and joints between curved and flat pieces. As suggested by the variety of groove weld symbols, there are many ways to make a groove weld, the differences depending primarily on the geometry of the parts to be joined and the preparation of their edges. Weld metal is deposited within the groove and penetrates and fuses with the base metal to form the joint. (Note: for the sake of graphical clarity, the drawings below generally do not show the penetration of the weld metal. Recognize, however, that the degree of penetration is important in determining the quality of the weld.)

The various types of groove weld are:

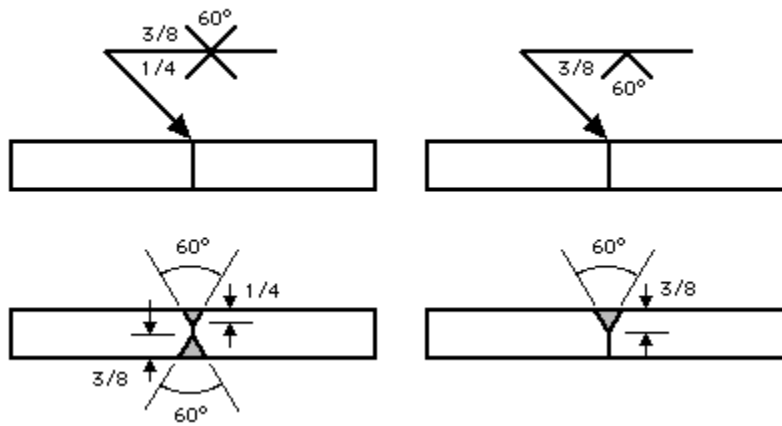
The **square** groove weld, in which the "groove" is created by either a tight fit or a slight separation of the edges. The amount of separation, if any, is given on the weld symbol.



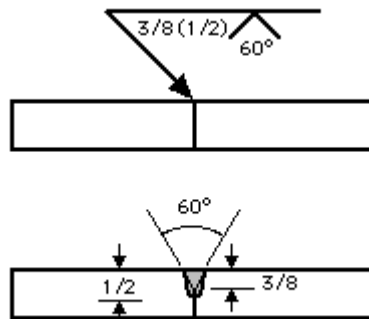
The **V-groove** weld, in which the edges of both pieces are chamfered, either singly or doubly, to create the groove. The angle of the V is given on the weld symbol, as is the separation at the root (if any).



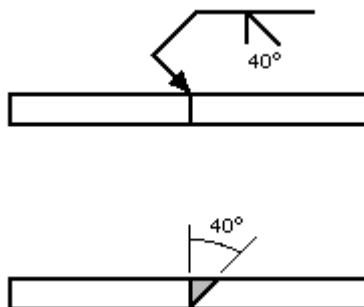
If the depth of the V is not the full thickness--or half the thickness in the case of a double V--the depth is given to the left of the weld symbol.



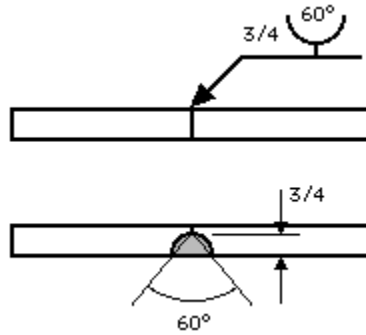
If the penetration of the weld is to be greater than the depth of the groove, the depth of the **effective throat** is given in parentheses after the depth of the V.



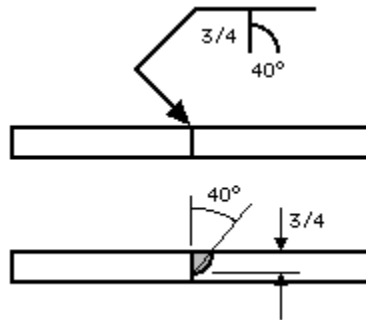
The **bevel** groove weld, in which the edge of one of the pieces is chamfered and the other is left square. The bevel symbol's perpendicular line is always drawn on the left side, regardless of the orientation of the weld itself. The arrow points toward the piece that is to be chamfered. This extra significance is emphasized by a break in the arrow line. (The break is not necessary if the designer has no preference as to which piece gets the edge treatment or if the piece to receive the treatment should be obvious to a qualified welder.) Angle and depth of edge treatment, effective throat, and separation at the root are described using the methods discussed in the [V-groove](#) section.



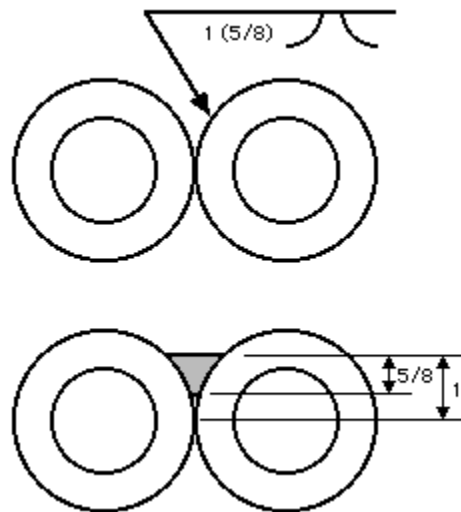
The **U-groove** weld, in which the edges of both pieces are given a concave treatment. Depth of edge treatment, effective throat, and separation at the root are described using the methods discussed in the [V-groove](#) section.



The **J-groove** weld, in which the edge of one of the pieces is given a concave treatment and the other, is left square. It is to the U-groove weld what the bevel groove weld is to the V-groove weld. As with the bevel, the perpendicular line is always drawn on the left side and the arrow (with a break, if necessary) points to the piece that receives the edge treatment. Depth of edge treatment, effective throat, and separation at the root are described using the methods discussed in the [V-groove](#) section.

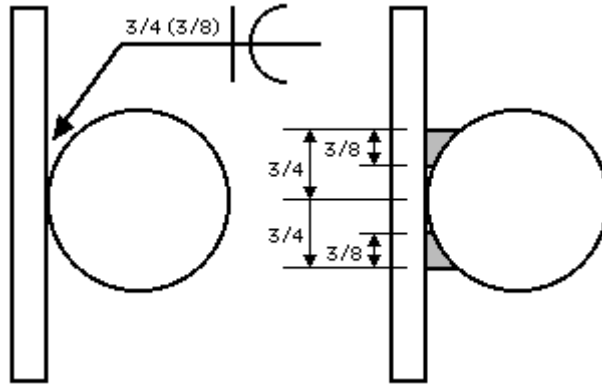


The **flare-V** groove weld commonly used to join two round or curved parts. The intended depth of the weld itself is given to the left of the symbol, with the weld depth shown in parentheses.

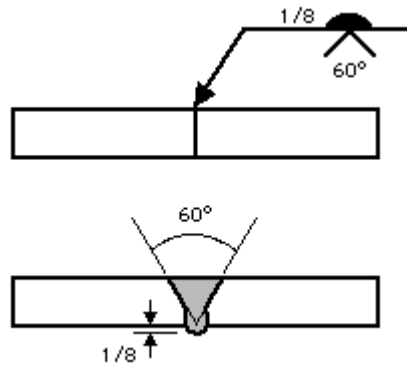


The **flare bevel** groove weld commonly used to join a round or curved piece to a flat piece. As with the flare-V, the depth of the groove formed by the two curved surfaces and the intended depth of the weld itself are given to the left of the symbol, with the

weld depth shown in parentheses. The symbol's perpendicular line is always drawn on the left side, regardless of the orientation of the weld itself.



Common supplementary symbols used with groove welds are the **melt-thru** and **backing bar** symbols. Both symbols indicate that complete joint penetration is to be made with a single-sided groove weld. In the case of melt-thru, the root is to be reinforced with weld metal on the back side of the joint. The height of the reinforcement, if critical, is indicated to the left of the melt-thru symbol, which is placed across the reference line from the basic weld symbol.



When a backing bar is used to achieve complete joint penetration, its symbol is placed across the reference line from the basic weld symbol. If the bar is to be removed after the weld is complete, an "R" is placed within the backing bar symbol. The backing bar symbol has the same shape as the plug or slot weld symbol, but context should always make the symbol's intention clear.

