

SUGGESTIONS FOR PREHEATING STRUCTURAL STEEL

Second edition

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TABLE OF CONTENTS

1	INTRODUCTION.....	3
2	WHY SHOULD WE PREHEAT	4
3	WHEN SHOULD WE PREHEAT.....	4
4	HOW SHOULD WE PREHEAT	4
5	MEASURING PREHEAT	5
6	PREHEAT, MINIMUM INTERPASS AND MAXIMUM INTERPASS TEMPERATURE....	5
7	WHERE TO MEASURING PREHEAT	6
8	SUMMARY.....	10
9	QUESTIONS.....	10

1 INTRODUCTION

- 1.1 This guide is not meant to replace the preheat information on CWB or AWS approved Welding Procedure Specifications (WPS) or Welding Procedure Data Sheet(s) (WPDS). Follow the preheat information on approved WPS or WPDS.
- 1.2 Use this guide at your own risk.
- 1.3 Follow the information in:
 - a) CSA W59, latest revision.
 - b) AWS D1.1, latest revision.
 - c) AWS approved WPS
 - d) CWB approved WPS and / or WPDS.
 - e) Company policies and safe practices

2 WHY SHOULD WE PREHEAT

2.1 Why should we preheat:

- a) It slows the cooling rate which offers more resistance to cracking.
- b) The slower cooling rate gives more time for hydrogen to escape, reducing the potential for cracking.
- c) Reduces shrinkage stresses, especially in highly restrained joints.
- d) It can help to ensure mechanical properties such as ductility and impact properties.

3 WHEN SHOULD WE PREHEAT

3.1 When should preheat be used:

- a) When working to welding codes, the minimum preheats must be followed.
- b) In some cases higher preheat temperatures may be needed with highly restrained joints or for welding repairs.
- c) Thick base metal.
- d) Base metal chemistry.
- e) Low ambient temperature.
- f) Weld metal hydrogen content.
- g) Low heat inputs.

4 HOW SHOULD WE PREHEAT

4.1 Choosing the right method for your job, whether it be torch heating, induction, or electrical resistance, could make the difference between a successful weld or a costly error.

- a) Flame or torch preheating equipment is cheap and is widely used for structural steel. Be careful of the flame distance so not to overheat the material in spots. When preheating steel with a torch, water will form several inches in all directions from the flame, this is a chemical reaction from the gas. Water condense on the plate until the plate get hot enough to drive off the moisture. Water does not come out of steel.
- b) Electrical resistance offers more control of the preheat temperature. Can be set up and turned on before the shifts starts and be ready for the welders for the start of a shift. Equipment is costly, thermocouples wires need to be welded on, and some weldments can be time consuming to cover.
- c) Induction heating is the most costly, but seems the easiest to use. It heats the steel quicker. Water cooled blankets are recommended. The setup is very quick.

5 MEASURING PREHEAT

5.1 Preheat can be measured in several ways:

- a) Infrared thermometers are cheap and must be calibrated. The surface condition of the material will have an effect on the reading. Shiny, rusty or painted surfaces will give different readings. Read the manufacturer's instructions to determine the best method to get an accurate temperature reading. If they get dropped or are handled roughly they may need to be recalibrated.
- b) Contact thermometers must be calibrated and are more accurate than the infrared type. If they get dropped or are handled roughly, they may need to be recalibrated.
- c) Temperature-indicating crayons such as Tempilstik, in my opinion are the most accurate. They are very cheap and come with documentation of calibration of +/- 1 degree. No need for calibration. This is the only method I use.

6 PREHEAT, MINIMUM INTERPASS AND MAXIMUM INTERPASS TEMPERATURE

- 6.1 **Preheat:** Preheat means the minimum preheat temperature before welding. This temperature shall be maintained while welding, unless a minimum interpass temperature is stated. The preheat should be uniform throughout and around the joint. Non-uniform heating can cause higher residual stresses and or undesirable metallurgical changes. The heat source should be placed on one side and measure the minimum preheat temperature on the opposite side. Sometimes it's impossible to get at the back side. When heating and checking the minimum preheat temperature on the same side, a rule of thumb is to remove the torch, wait 1 minute for every 1" (25 mm) of base metal thickness before checking the temperature. Try a test piece in your shop, preheat from one side only, remove torch, wait a minimum of 1 minute, then check the opposite side to see if the minimum preheat temperature has reached the back side. Equipment varies from shop to shop, adjust time to thickness as needed in your shop.
- 6.2 **Minimum interpass temperature:** Is the minimum temperature reached between weld passes. Usually the minimum interpass temperature is the same as the minimum preheat temperature, unless someone states a temperature that is different from the minimum preheat temperature.
- 6.3 **Maximum interpass temperature:** Is needed on multipass welds and is the maximum temperature allowed for a grade of material. This temperature should be checked just before putting the next bead of weld. The temperature should be checked at the next bead location or beside the joint preparation. If the temperature is above the maximum interpass temperature, you must wait until the temperature drops.

7 WHERE TO MEASURING PREHEAT

- 7.1 AWS D1.1 – 2015: States preheat and all subsequent minimum interpass temperatures shall be maintained during the welding operation for a distance at least equal to the thickness of the part (but not less than 3 in. [75 mm]) in all directions from the point of welding.
- 7.2 CSA W59 – 2013: States the material to be welded shall be at or above the minimum specified temperature for a distance at least equal to the thickness of the part being welded, but not less than 75 mm (3"), both laterally and in advance of the welding.

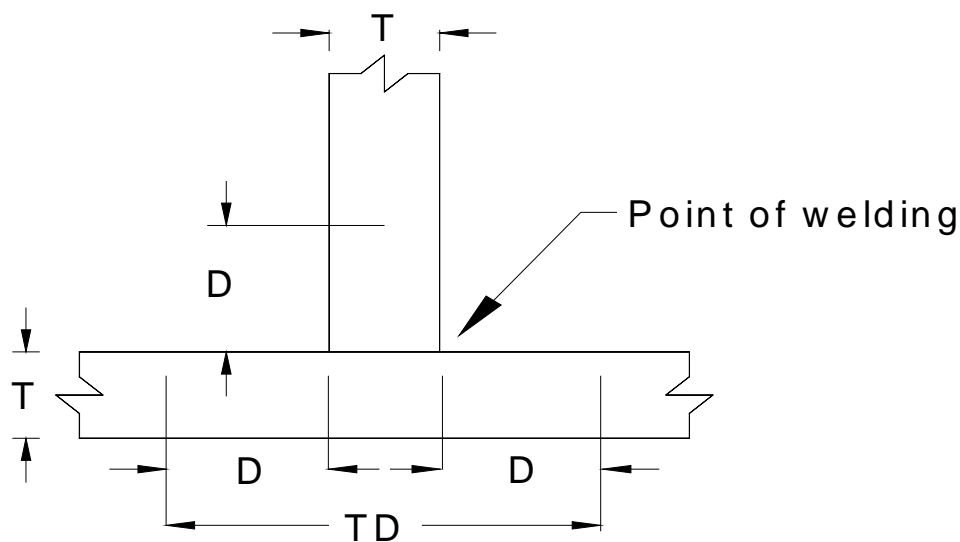


Figure 7.1: Fillet Weld

- 7.3 **Fillet weld:** Apply the preheat on the back side and under the joint. Check the minimum preheat temperature on the weld side. Sometimes it's impossible to get at the back side. If applying preheat and checking the minimum preheat temperature on the same side, remove the torch, wait approximately 1 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. See section 7.1 or 7.2 for D dimensions.

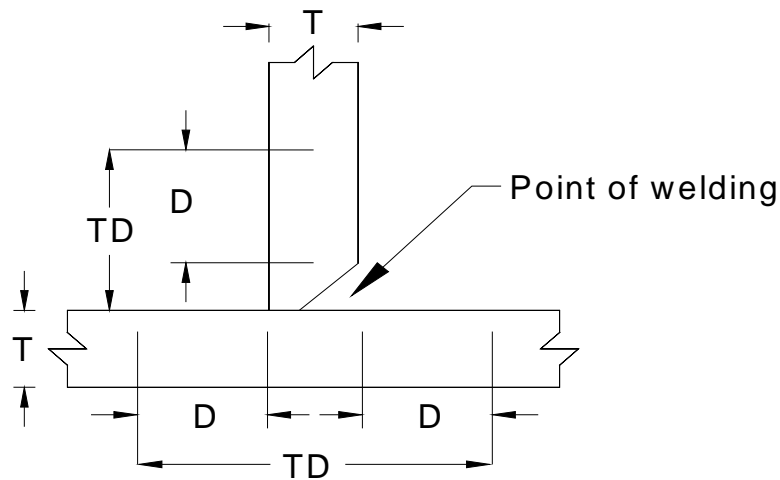


Figure 7.2: Partial Penetration T Joint

7.4 **Partial penetration T joint:** Apply the preheat on the back side and under the joint. Check the minimum preheat temperature on the weld side. Sometimes it's impossible to get at the back side. If applying preheat and checking the minimum preheat temperature on the same side, remove the torch, wait approximately 1 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. See section 7.1 or 7.2 for D dimensions.

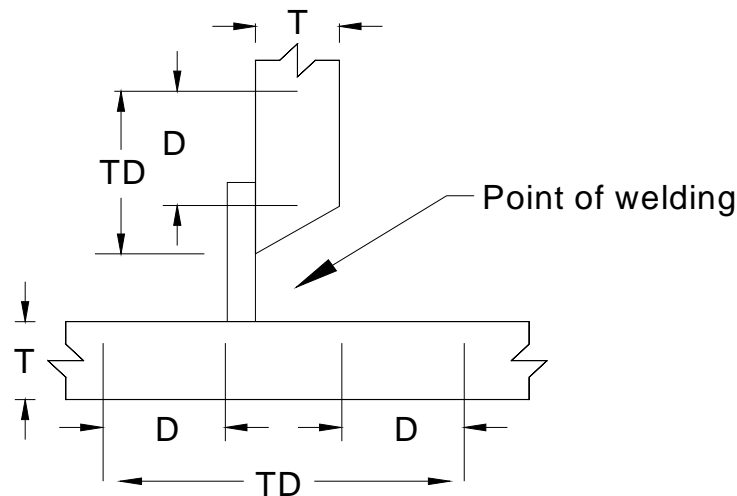


Figure 7.3: Complete Penetration T Joint

7.5 **Complete penetration T joint:** Apply the preheat on the back side and under the joint. Check the minimum preheat temperature on the weld side. Sometimes it's impossible to get at the back side. If applying preheat and checking the minimum preheat temperature on the same side, remove the torch, wait approximately 1 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. See section 7.1 or 7.2 for D dimensions.

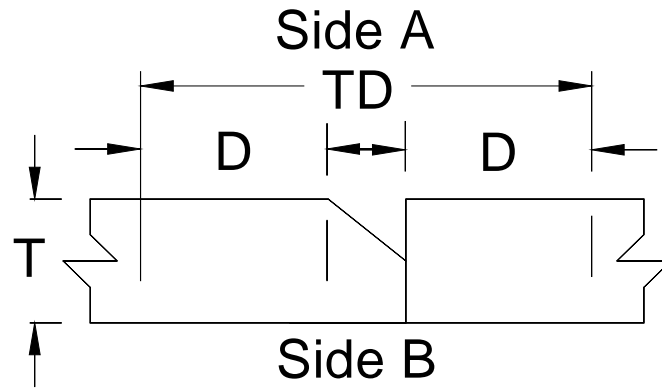


Figure 7.4: Partial Penetration Butt Joint

7.6 **Partial penetration butt joint:** Apply preheat on side B and check the minimum preheat temperature on side A. Sometimes it's impossible to get at the back side. If applying preheat and checking the minimum preheat temperature on the same side, remove the torch, wait approximately 1 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. See section 7.1 or 7.2 for D dimensions.

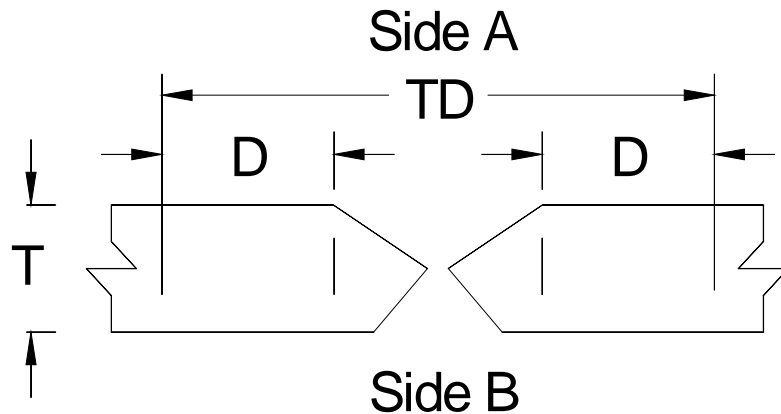


Figure 7.5: Complete Penetration Butt Joint

7.7 **Complete penetration butt joint:** Side A to be welded first, apply preheat on side B, check minimum preheat temperature on side A. If you cannot get to side B, apply the minimum preheat to side A and after taking away the torch wait approximately 1 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. See section 7.1 or 7.2 for D dimensions.

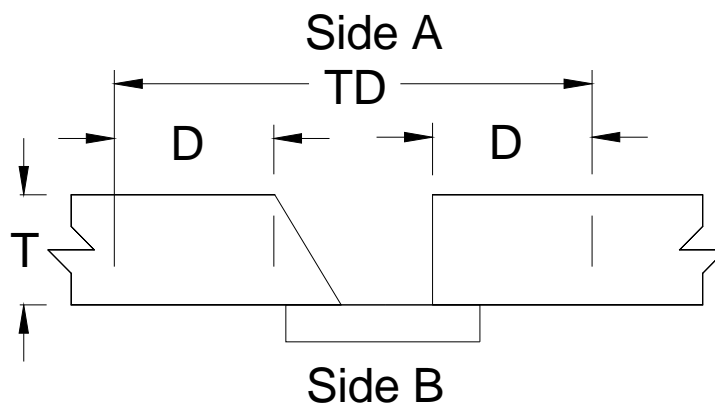


Figure 7.6: Complete Penetration Butt Joint with Backing

7.8 **Complete penetration butt joint:** Apply preheat on side B and check the minimum preheat temperature on side A. Sometimes it's impossible to get at the back side. If applying preheat and checking the minimum preheat temperature on the same side, remove the torch, wait approximately 1 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. See section 7.1 or 7.2 for D dimensions.

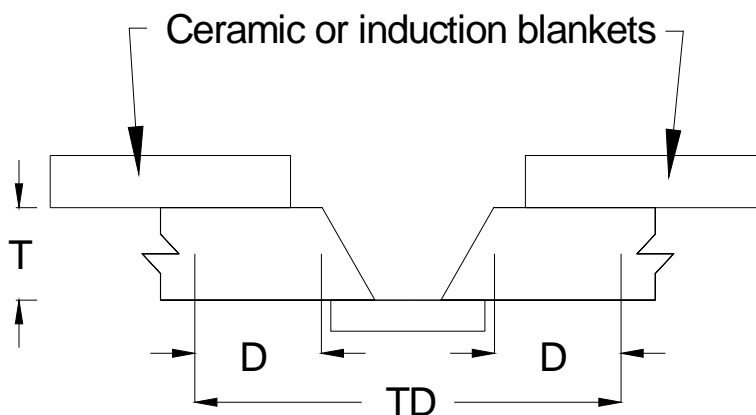


Figure 7.7: Complete Penetration Butt Joint with Ceramic or Induction blankets

7.9 **Complete penetration butt joint with ceramic or induction blankets:** After the minimum preheat temperature is reached by the ceramic or induction system, check the minimum preheat temperature on the back side. If you cannot get to the back side, check the minimum preheat temperature on the top side near the preparation, wait approximately 2 minute for each 1" (25 mm) of metal thickness before checking the temperature. See section 6.1 for test procedure. D equals the minimum distance required by code for the minimum preheat temperature. TD = total distance. Try a test piece and see if this time to thickness works in your shop. See section 7.1 or 7.2 for D dimensions.

8 SUMMARY

- 8.1 Preheat must be done correctly with appropriate controls to be effective. Preheat can be applied through various means depending on the thickness, shape and available equipment. Whatever method is chosen, I would suggest every welder, welding supervisor and inspector have a temperature-indicating crayon to check and monitor the minimum preheat and maximum interpass temperature. It could mean the difference of having a weldment to send to a customer or having a boat anchor.

9 QUESTIONS

Questions or tech. support? Email: raycormier@rogers.com