Welding Repair for Structural Cracks

General

Your regular maintenance schedule should include an inspection of the chassis and other major weldments at regular intervals. Allied Systems Company suggests that you clean and inspect your unit for cracks quarterly, more often in severe applications. Once a crack is found it's important to repair it immediately using the procedures outlined in this bulletin.

Over the years we have observed many successful and unsuccessful attempts to repair cracks. This service procedure was developed to outline proper crack repair procedures—procedures that have proven to be successful. All crack repairs should be carried out by a certified welder.

Welding Fundamentals

(Preheat, Interpass Temperatures, and Postheat)
Preheating involves heating the base metal immediately surrounding the weld to a specific temperature prior to welding. There are four reasons to preheat:

1. It slows cooling, producing more ductile metallurgical structure with greater resistance to cracking;
2. Slower cooling provides an opportunity for hydrogen that may be present to diffuse out harmlessly, reducing potential for cracking;
3. It reduces stresses in the weld and adjacent base metal, which is especially important in highly restrained joints; and
4. It raises some steels above the temperature at which brittle fracture would occur in fabrication. Preheat may be applied in a furnace, using electrical strip heaters, induction, radiant heaters, or heating torches.

When heating the joint to be welded, the preheat temperature should be established at a distance at least equal to the thickness of the thickest member, but not less than 3 inches (75mm) in all directions from the welding point. To ensure that the full material volume surrounding the joint is heated, it is recommended practice to heat the opposite side of that which is to be welded and to measure the surface temperature adjacent to the joint.

Interpass temperature refers to the temperature of the material in the weld area immediately before the second and each subsequent pass of a multi-pass weld. In practice, the minimum specified interpass temperature is often equal to the minimum specified preheat temperature. Interpass temperature is probably more important than preheat temperature with regard to the mechanical and microstructural properties of weldments. For instance, the yield and ultimate tensile strengths of the weld metal are both a function of interpass temperature. High interpass temperature tends to reduce weld metal strength.

The minimum interpass temperature must be sufficient to prevent cracking, while the maximum interpass temperature must be controlled to provide adequate mechanical properties. The following variables must be considered: time between passes, base metal thickness, preheat temperature, ambient conditions, heat transfer characteristics, and heat input from welding.

The application of postweld heat is often used to improve the properties of the weldment. The goal of applying postweld heat is to increase the resistance to brittle fracture and relaxing residual stresses. Other desired results from post heat may include hardness reduction and material strength enhancements.

Controlling Preheat and Interpass Temperatures

One accepted method of controlling the preheat and interpass temperature is to use two temperature indicating crayons available at your local welding supply store. A surface applied temperature indicating crayon (often referred to by the trade name, Tempilstik) melts when the material to which it is applied reaches the crayon's melting temperature. The crayons are available in a variety of melting temperatures, and each individual crayon is labeled with its approximate melting point.

One temperature indicating crayon is typically used to measure both minimum specified preheat temperature and the minimum specified interpass temperature, while the second is a higher temperature crayon used to measure the maximum specified interpass temperature.

The welder first heats the joint to be welded and checks the base metal temperature at the designated location (typically 3 inches from the weld), by marking the base metal with the first temperature indicating crayon. When the minimum specified preheat temperature is reached (when the first crayon melts), the first welding pass can begin. Immediately before the second and subsequent passes, the minimum and maximum interpass temperature should be checked in the proper location (typically 1 inch from the weld). The lower temperature crayon should melt, indicating that the temperature of the base metal is greater than the melting temperature of the crayon, while the higher temperature crayon should not melt, indicating that the base metal temperature is not above the maximum interpass temperature.

If the lower temperature crayon does not melt, additional heat should be applied to the joint until the crayon mark on the base metal melts. And, if the upper temperature crayon melts, the joint should be allowed to slowly cool until the upper temperature crayon no longer melts, while the lower temperature crayon does melt. Then the next welding pass can begin. A joint shall be completely welded before it is allowed to cool below the specified temperature to prevent cracking.

As a general rule, the interpass temperature must be maintained for a distance at least equal to the thickness of the thickest welded part (but not less than 3 inches, or 75mm) in all directions from the point of welding. To ensure that the interpass temperature does not exceed the maximum in the base metal immediately adjacent to the weld, the maximum interpass temperature should be measured at a distance of 1 inch from the weld.

Note: On your Wagner unit, postweld heat is applied to swivel boxes on Chipdozers, and on Lumberjacks it is applied to swivel boxes, tail posts and wheel hubs. Allied Systems Company recommends that these complex weldments be returned to the factory when repair welding is necessary.

Minimum and Maximum Preheat and Interpass Temperatures

Your Wagner unit is constructed using medium-strength and high-strength steels. Typically, the boom and certain parts of the carriage, axle housing and swivel box on a Lumberjack are constructed of high-strength steel. The swivel box and bucket on a Chipdozer are constructed of high-strength steel. Other parts of your unit are mostly constructed using medium-strength steel.

The preheat temperatures and interpass temperatures listed below are intended to be used at all times (for all steels) when welding on your Wagner unit.

Thickness of Thickest Part at Point of Weld	Manual or Semi-Automatic Gas Metal-Arc Welding, Flux Cored Arc Welding or Manual Shielded Metal-Arc Welding with Low Hydrogen Electrodes	
	Minimum Preheat Temperature	Maximum Interpass Temperature
To & Including ¾”	100°F (38°C)	400°F (205°C)
¾” to 1 ½”	175°F (80°C)	400°F (205°C)
1 ½” to 2 ½”	225°F (110°C)	450°F (230°C)
Over 2 ½”	275°F (135°C)	450°F (230°C)

Table 1. Minimum Preheat and Maximum Interpass Temperatures

When joining steels of different thicknesses with groove welds, the preheat and interpass temperatures for the average plate thickness shall be used. For fillet welds, the preheat shall be used for the thickest plate being welded.

When moisture is present on the base metal it shall be preheated to 220°F (105°C) before welding begins.

Procedures for Repairing Structural Cracks

Use the following instructions to repair structural cracks:

1. Read, understand, and heed all safety information found in your operator's manual.
2. Before starting work move the machine to a level surface, engage the parking brake, and stop the engine.
3. Chock the wheels.
4. Set the Battery Disconnect switch to "OFF" before performing any welding. Turn the switch counterclockwise to disconnect the batteries. If your machine is not equipped with a battery disconnect switch, disconnect battery cables.
5. Disconnect ECM (Electronic Control Module). The ECM connector is located on the engine.
6. Disconnect PLC (Programmable Logic Controllers) or electronic control modules if so equipped.
7. Steam clean the entire machine. Inspect the unit for cracks.
8. Remove crack and/or defective material with air carbon arc process or equivalent while creating a weld joint consistent with AWS B-P2 for flat position welding or AWS B-P4 when welding in the vertical position. See Figures 1 & 2 below.
9. Grind clean the surface(s) to be welded.
10. Verify removal of crack with a magnetic particle test or equivalent.
11. Preheat to the temperature specified in Table 1. Preheat varies depending on material thickness.
12. Use Dual Shield 11 71 All-position electrodes and AWS Class E71T-1 or equivalent.
13. Inspect finished weld for smoothness and quality.
14. Repaint the repair area to protect against corrosion.

For questions or concerns, please contact your local dealer or Allied Systems Company Service Department at (503) 625-2560.

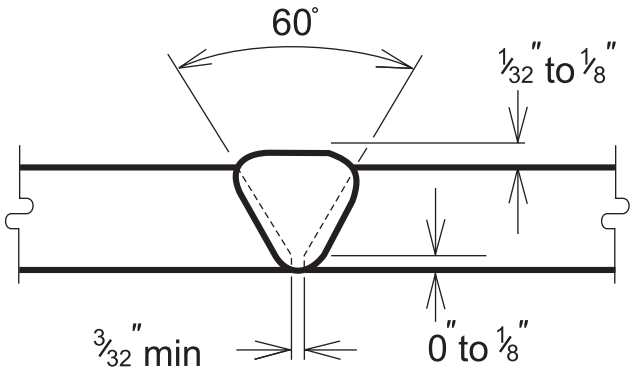

Figure 1. B-P2 - Single Vee Groove

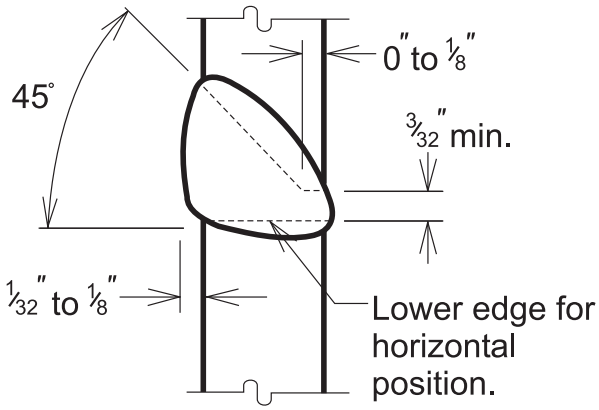

Figure 2. B-P4 - Single Bevel Groove