

Department of Education
SPTVE
Shielded Metal Arc Welding
(SMAW) 9
Weld Defects, Causes, and Remedies
Quarter 2: Week 6 Module



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EXPECTATIONS

At the end of the module, you should be able to:

1. identify welding defects;
2. explain the causes and remedies for welding defects; and
3. understand the importance of identifying welding defects in welding and rectifying remedies.



PRE-TEST

A. Directions: Read the statements carefully and choose the letter of the correct answer. Write your answer in a separate sheet of paper.

1. Spatter are formed because of:
 - A. slow current
 - B. excessive arc current
 - C. quality machine and base metal
 - D. electrode coated with proper flux engridients.
2. What is the remedy of incomplete penetration?
 - A. excessive arc current
 - B. providing insufficient shielding gases.
 - C. reducing travel speed during welding.
 - D. Electrode coated with improper flux ingredients
3. Welding defects are broadly classified into:
 - A. one category
 - B. two categories
 - C. three categories
 - D. four categories
4. What causes bad welding?
 - A. good quality of electrodes
 - B. properly installed power sources
 - C. fundamental difficulties in the welding operation.
 - D. proper technique used by experienced or skilled welder.
5. Your finished weld should be _____:
 - A. with undercut
 - B. uneven thickness
 - C. slag inclusions
 - D. with fine ripples

B. Directions: Read the statements carefully and choose the weld defects from the box below. Write your answer in a separate sheet of paper.

6. A narrow gutter on the base metal next to the weld metal near the edge.
7. A condition that manifests itself inform of gases or air bubbles that are trapped in the weld metal.
8. Oxides that are mainly trapped in the weld or on the surface of the weld zone.
9. This results when the depth of the weld is not sufficient.
10. This occurs when metal particles from the weld is stuck on the area adjacent to the weld area.

A. incomplete penetration

C. porosity

E. spatters

B. melt through

D. slag inclusions

F. undercut



LOOKING BACK

Directions: Differentiate the two[2] figures below and enumerate at least two[2] differences you observed. Write your answer in a separate sheet of paper.

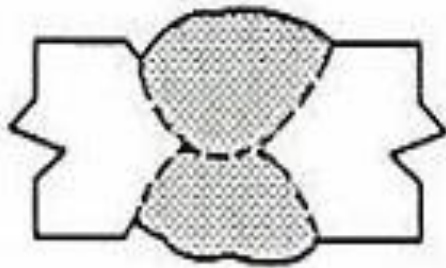


Figure 1

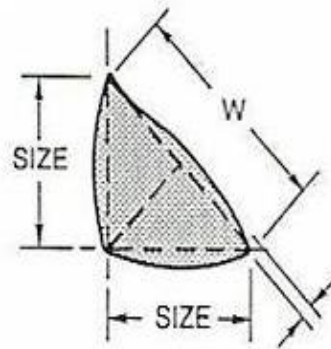


Figure 2



BRIEF INTRODUCTION

Welding defects can be defined as the irregularities formed in the given weld metal due to wrong welding process or incorrect welding patterns, etc. The defect may differ from the desired weld bead shape, size, and intended quality. Some of the defects may be allowed if the defects are under permissible limits but other defects such as cracks are never accepted.

All welds should be visually inspected for defects. Defects in weld joints could result in the rejection of parts and assemblies, costly repairs, significant reduction of performance under working conditions and, in extreme cases, catastrophic failures with loss of property and life.

Welding defects can be classified into two types as external and internal defects:

EXTERNAL WELDING DEFECTS can be identified by visual inspection method like Dye Penetrant and Magnetic Particle Testing.

1. Weld Crack

Cracks are the most common defects and they can occur anywhere on the surface of the weld material. Some cracks can also be present inside the weld material especially on areas that are affected by direct heat (HAZ).

Cracks presents themselves in two major types:

- Hot Cracks- These cracks occur during the welding or during crystallization where temperature can be as high as 10000-degrees Celsius.
- Cold Cracks- Cold cracks occur after completion of the welding process or during the solidification process. They are normally visible after several hours or even several days after welding.

Causes of Cracks

- Wrong joint design.
- Contamination of the base metal coupled by poor ductility.
- Use of hydrogen gas as a shield gas while welding ferrous metals.
- High content of carbon and sulfur in the base metal.
- High welding current.
- Rapid cooling of the weld joint.
- Inadequate preheating.
- Residual stress can also lead to cracks.

Remedies

- Consider a low-hydrogen electrode.
- Use the correct joint design.
- Use proper amperage settings.

2. Undercut

Undercuts presents themselves as narrow gutters on the base metal next to the weld metal near the edge. This occurs when the base metal melts away from the weld area reducing the thickness of the base metal and the result is a weakened workpiece. These undercuts run parallel to the metal weld.

Causes of Undercuts

- Too fast weld speed.
- High arc voltage.
- Too large electrode.
- Use of wrong filler metal.

Remedies

- Decrease the travel speed, but at the same time not too slow.
- Use the right electrode size and it should be positioned at the correct angle; between 30 to 45 degrees.
- Reduce the length of the arc and lower the voltage.
- Use proper current and pay close attention to thinner areas and edges.

3. Spatter

Spatter occurs when metal particles from the weld is stuck on the area adjacent to the weld area. This defect is common in gas metal arc welding and it is sometimes very hard to remove the particles.

Causes of Spatter

- Running on very high amperage can cause spatter.
- Use of incorrect polarity.
- Irregular wire feeding.
- Contamination of the weld surface
- This defect can also result from improper gas shielding.
- Positioning the electrode at a very steep angle.

Remedies

- Eliminate any feeding issues.
- Use the right polarity as per weld requirements.
- Adjust the amperage settings.
- Clean up the surface before you do any welding.
- Use proper gas shielding.
- Increase the plate angle according to the condition of the welding.

4. Porosity

Porosity is a condition that manifests itself in the form of gases or air bubbles that are trapped in the weld metal. It is mainly because of contamination of the weld metal, which is weakened, and it can collapse with time.

Causes of Porosity

- It can occur when the electrode is not well coated.
- Presence of oil or rust on the weld surface can cause porosity.
- Use of incorrect shielding gas or improper shielding.
- Too high gas flow.
- Presence of moisture on the weld zone.
- Improper surface treatment.

Remedies

- Clean the materials and the weld surface before you begin welding.
- Slow the welding process to allow the gases to escape.
- Make sure that the surface is free from oil or rust and any other contaminant.
- Make sure that the gas flow meter is configured with the correct flow settings.

5. Overlap

Overlap results when the weld pool overflows on the surface of the weld metal. The molten metal does not fuse with the base metal leading to an overlap which may extend to form an angle not exceeding 90 degrees.

Causes of Overlaps

- Large deposition at a go.
- Using the electrode at the wrong angle.
- Using too high current.
- Longer arc.

Remedies

- Employ the right welding technique to avoid wrong arc length.
- Position the electrode at the appropriate angle.
- Use correct deposition during each run.
- Use low welding current.

6. Crater

It occurs when the crater is not filled before the arc is broken, which causes the outer edges to cool faster than the crater. This causes a stress and then crack is formed.

Causes of the Crater

- Incorrect torch angle.
- Use of large electrode:
- Improper welding technique

Remedies

- Using a proper torch angle may reduce the stress on the metal
- Using a small electrode may also decrease the crater.
- Use a proper technique.

INTERNAL WELDING DEFECTS requires a Non-Destructive (NDT) method like X-Ray or Ultrasonic Testing.

1. Slag Inclusion

Slag inclusions are compounds such as oxides that are mainly trapped in the weld or on the surface of the weld zone. These compounds are by products of welding processes such as stick welding and arc welding. In addition, insufficient cleaning can leave some slag behind which reduces the strength of the weld and it can act as a starting point of serious cracking. Serious slag inclusion may require you to do a re-weld.

Causes of Slag Inclusion

- Too little current density which may not be sufficient to provide enough heat to melt the weld metal.
- Failure to do proper cleaning, especially after a welding pass.
- Too fast cooling of the weld pool may be a potential for slag inclusions.
- Welding at an inappropriate angle and wrong rate of travel.

Remedies

- Increase the current density to appropriate levels.
- Increase the welding speed so that weld and slag do not mix.
- Clean all surfaces including all edges and previous welds.
- Ensure that the weld pool cools down moderately, not too fast but not too slow either.

2. Incomplete Fusion

Lack of fusion or incomplete fusion occurs when the weld metal and the base metal are not accurately welded due to improper melting resulting into unfilled gap. Improper fusion can also occur between layers within the weld itself. Although this is an internal problem, it can be manifested on the outer surface too if the outer sidewall is not properly fused with the parent metal.

Causes of Incomplete Fusion

- Incomplete fusion can result from low heat input.
- Using wrong electrode diameter when compared to the thickness of the material.
- Too fast travel speed can lead to incomplete fusion.
- Sometimes the weld pool may be too large, running ahead of arc and this can lead to incomplete fusion.
- Improper placement of bead.

Remedies

- Try to increase the travel speed to minimize the chances of incomplete fusion.
- Position all beads properly to avoid sharp edges from meeting each other.
- Try to reduce the deposition rate.
- Make sure the molten weld does not flood the arc.

3. Necklace Cracking

It occurs in the use of electron beam welding where the weld does not penetrate properly. Therefore, the molten metal does not flow into the cavity and results in a cracking known as “Necklace Cracking”.

Causes of Necklace Cracking

- Improper welding technique.
- It occurs in materials such as nickel base alloys, stainless steel, carbon steels and Tin alloys.
- Using high speed of electron beam welding

Remedies

- Using a proper welding technique reduce the chances of necklace cracking.
- Using proper materials for welding.
- Using a constant speed during the welding process.

4. Incomplete Filled Groove or Incomplete Penetration

Incomplete penetration results when the depth of the weld is not sufficient. As such, the metal groove is not filled fully meaning that the weld does not extend through the entire joint.

Causes of an Incomplete Penetration

- Improper joint alignment
- Moving the bead too fast which means little deposition of the weld metal
- Too much space between welded metal can cause incomplete penetration.
- Using too low amperage which may not be enough to melt the metal completely.

Remedies

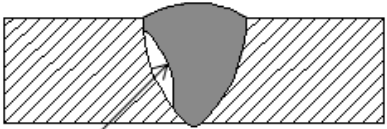
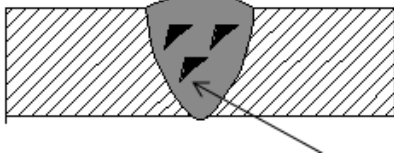
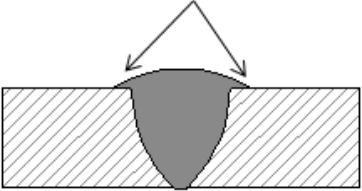
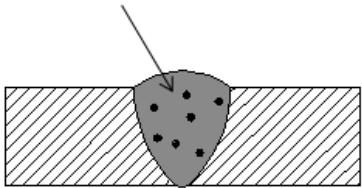
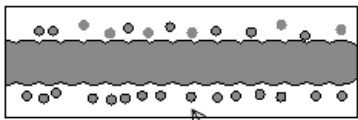
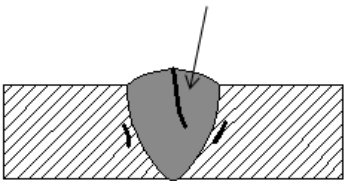
- Ensure enough deposition of the weld metal.
- Employ correct joint geometry and ensure proper alignment.
- Use proper welding amperage
- Reduce the speed of travel.



ACTIVITIES

Directions: Look at the illustrations. Identify welding defects, causes, and remedies. Use a separate sheet of paper for your answer.

| Illustration | Name of Welding Defect | Causes (atleast 1) | Remedies (atleast 1) |
|--------------|------------------------|--------------------|----------------------|
| <p>1.</p> | | | |

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| 3. |  | | |
| 4. |  | | |
| 5. |  | | |
| 6. |  | | |
| 7. |  | | |



REMEMBER

- Welding defects is the irregularities formed in the given weld metal due to wrong welding process or incorrect welding patterns, etc.
- There are 2 classified types of welding defects. These are internal and external defects.
- Internal defects include slag inclusion, incomplete fusion, necklace cracking, and incomplete filled groove or incomplete penetration.
- External defects include weld crack, undercut, spatter, porosity, overlap, and crater.



CHECK YOUR UNDERSTANDING

Directions: Write a reflection about the importance of identifying welding defects and rectifying remedies. Use separate paper for your answer.



POST TEST

A. Directions: Match the weld defect to its remedy and choose the letter of the best answer. Write your answer in a separate sheet of paper.

Weld Defect

1. slag inclusion
2. spatter
3. incomplete penetration
4. undercut

Remedy

- A. Employ correct joint geometry and ensure proper alignment.
- B. Ensure that the weld pool cools down moderately, not too fast but not too slow either.
- C. Make sure the molten weld does not flood the arc.
- D. Use the right electrode size and it should be positioned at the

5. incomplete fusion

correct angle; between 30 to 45 degrees.

E. Use the right polarity as per weld requirements.

B. Directions: Illustrate the following weld defects. Use a long bond paper for your performance.

6. weld crack
7. undercut
8. spatter
9. porosity
10. overlap

REFERENCES:

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Welding Guide Fabrication Shop, Ismael V. Palabrica

Metal Works 1, SEDP Series, Industrial Technology

Basic Manual Metal Arc Welding, National Training Center for Technical Education and Staff Development

Welding Principles and Applications, Larry Jeffus and Harold V. Johnson

Key to Correction:

| | | |
|----------|---------------------------|---------------------------|
| Posttest | 1. B | 1. B |
| | 2. C | 2. C |
| | 3. D | 3. D |
| | 4. C | 4. C |
| | 5. A | 5. A |
| | 6. undercut | 6. undercut |
| | 7. porosity | 7. porosity |
| | 8. slag inclusion | 8. slag inclusion |
| | 9. incomplete penetration | 9. incomplete penetration |
| | 10. spatters | 10. spatters |