TECHNOLOGY


# Welding Inspection

## Defects/Repairs

## Course Reference WIS 5

# Weld Defects

Defects which may be detected by visual inspection can be grouped under the following headings

- Cracks
- Solid inclusions
- Surface and profiles
- Misalignment (set-up irregularities)
- Gas pores and porosity
- Lack of fusion
- Mechanical damage
- Parent material damage
- Miscellaneous

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# Cracks

# Cracks.

Cracks that may occur in welded materials are caused generally by many factors and may be classified by shape and position, cracks are classed as planar.

***Classified by Shape***

- Longitudinal
- Transverse
- Branched
- Chevron

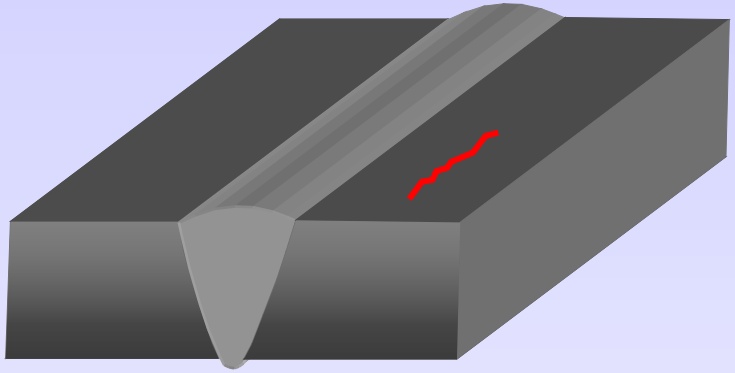
***Classified by Position***

- HAZ
- Centreline
- Crater
- Fusion zone
- Parent metal

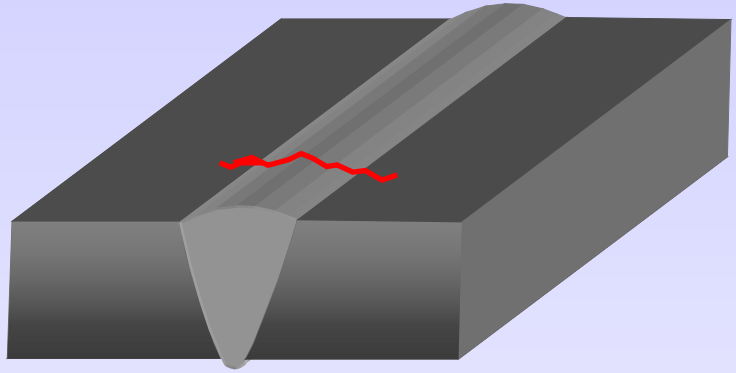
# Process Cracks

- Hydrogen induced cold cracking (HICC)
- Solidification cracking (Hot Tearing)
- Lamellar tearing
- Re heat cracking

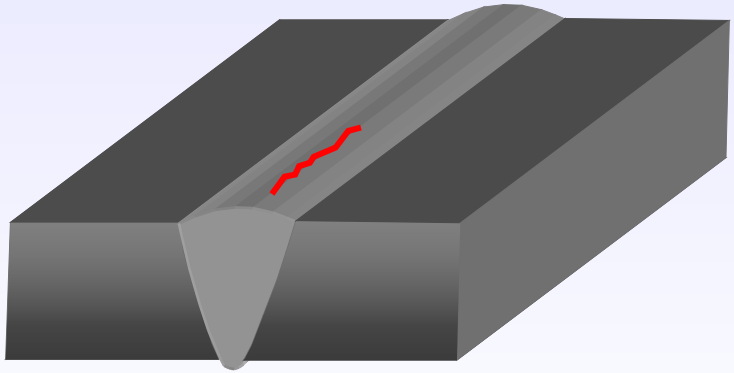
# Cracks



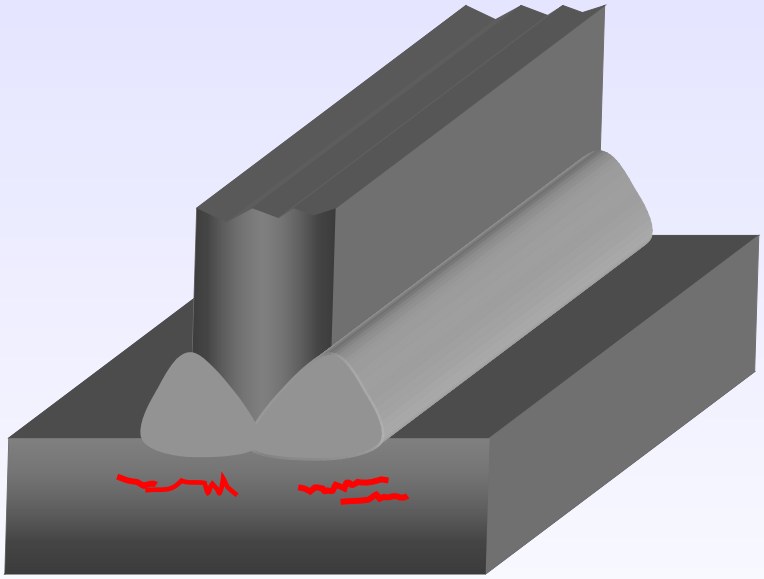
Longitudinal parent metal crack



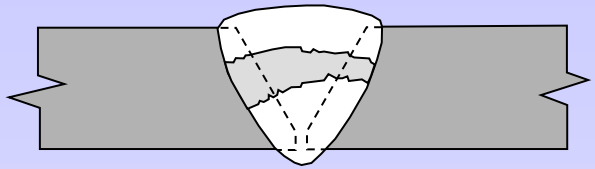
Transverse weld metal crack

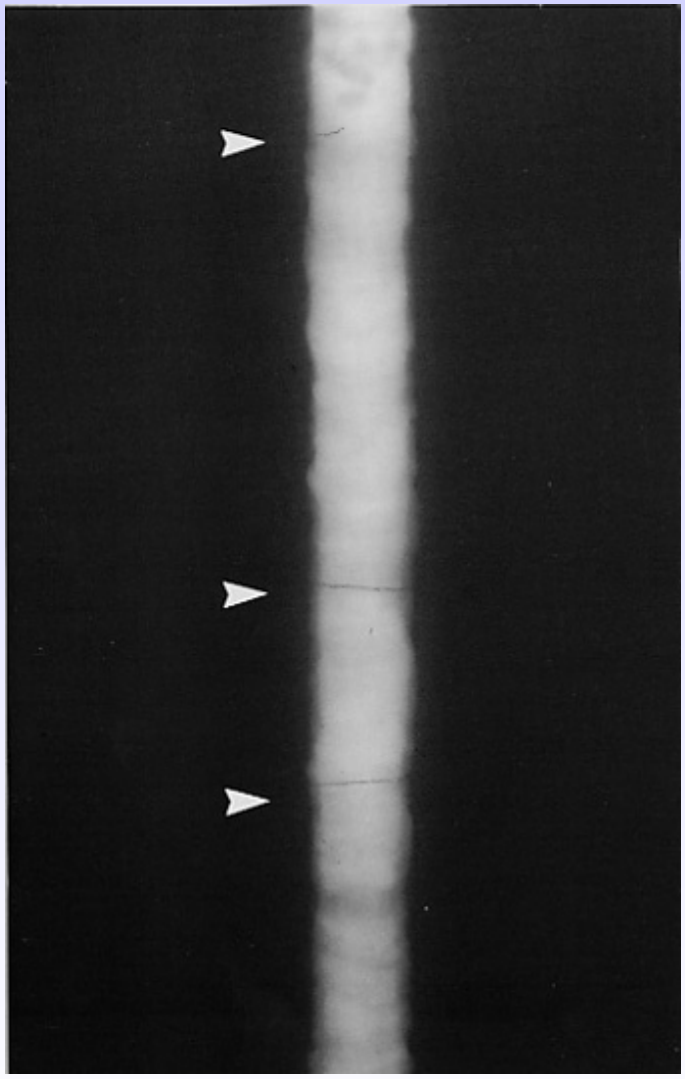


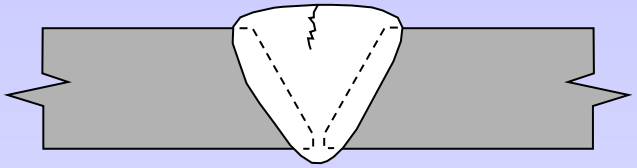
Longitudinal weld metal crack



Lamellar tearing







**Transverse crack**

**Longitudinal crack**

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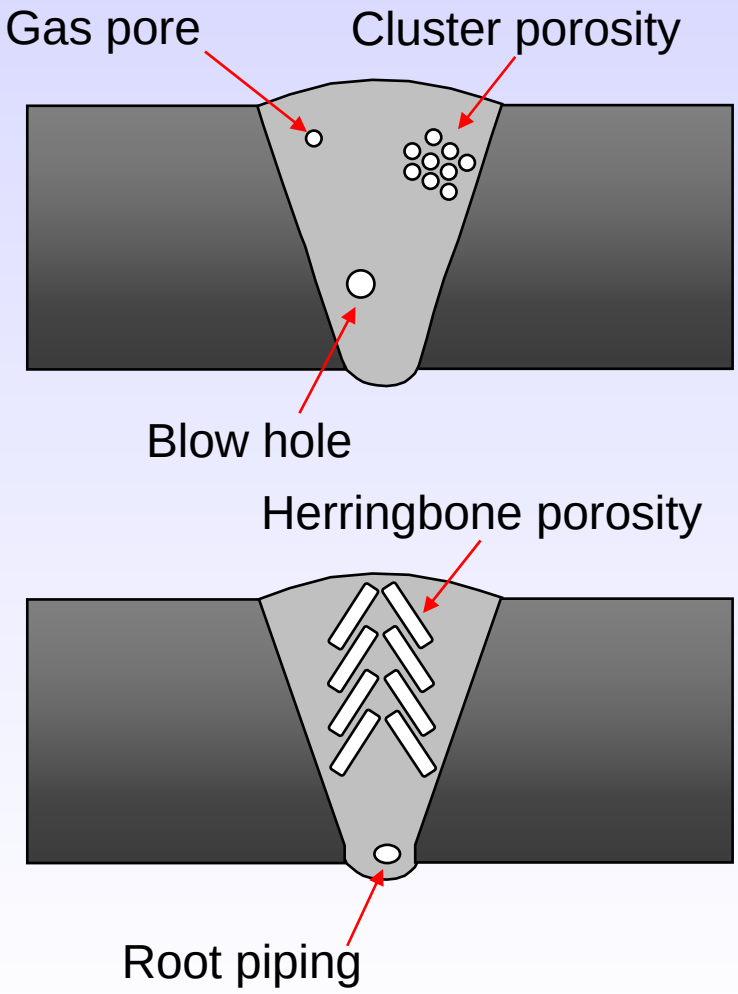
# Inclusions

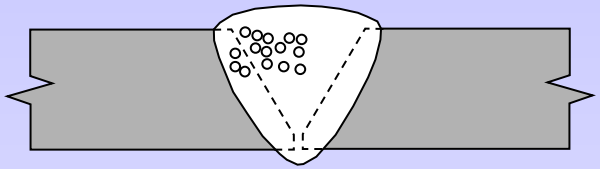
# Gas Cavities

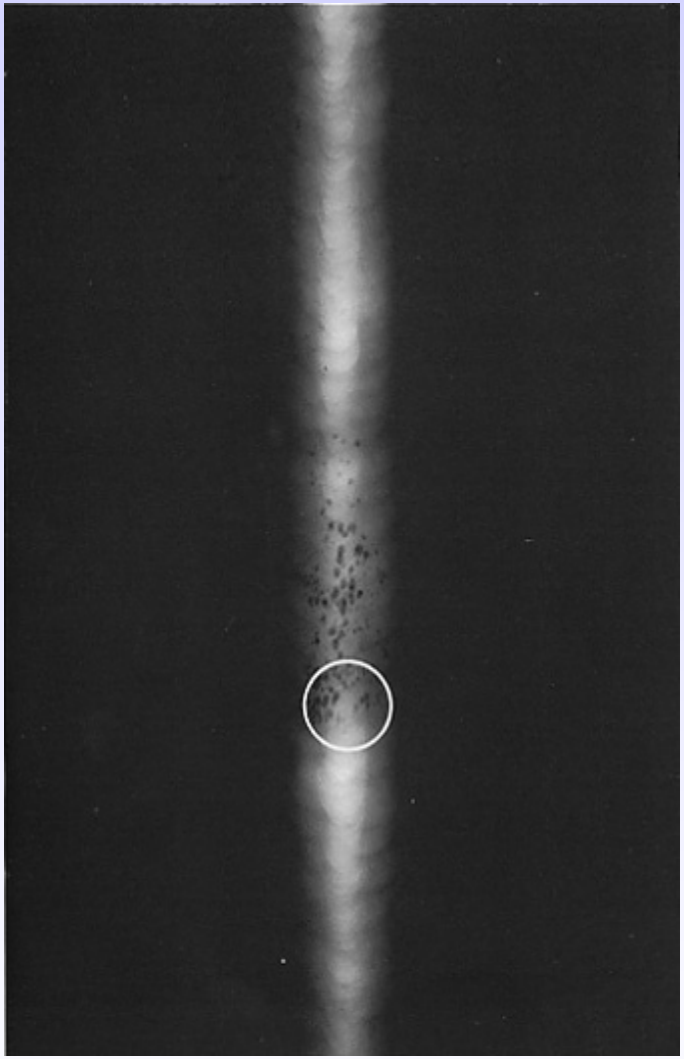
## Gas pore <1.5mm  Blow hole.>1.5mm



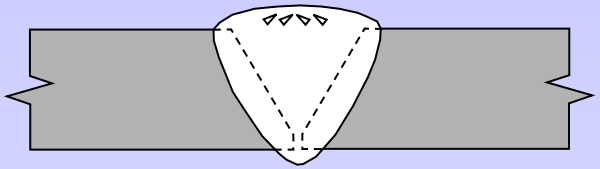

- Loss of gas shield
- Damp electrodes
- Contamination
- Arc length too large
- Damaged electrode flux
- Moisture on parent material
- Welding current too low

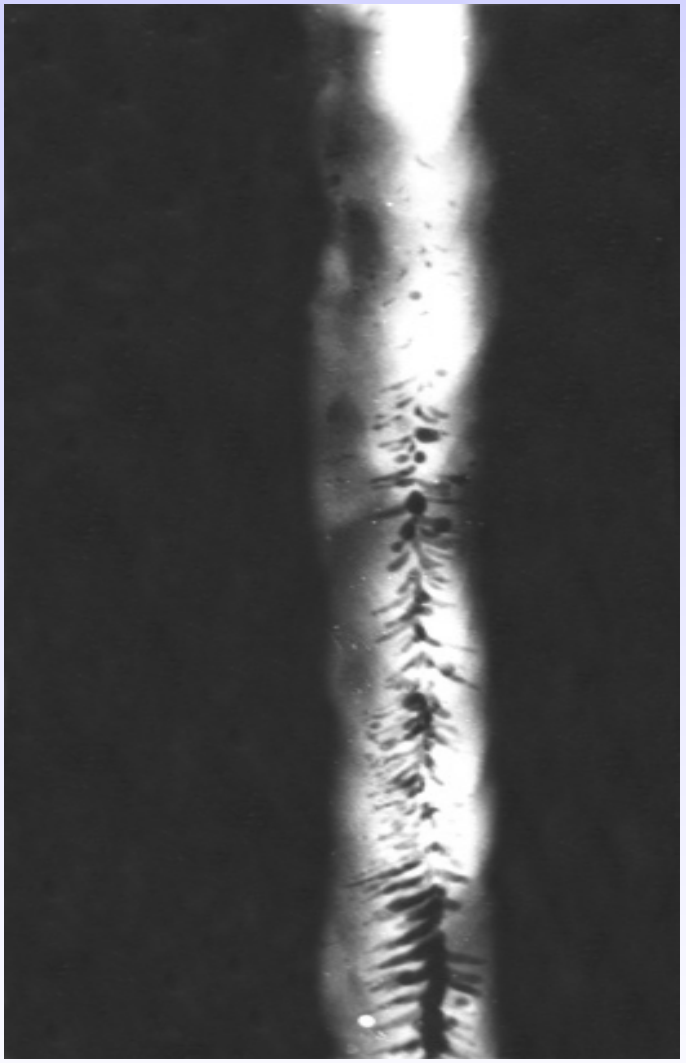
# Gas Cavities



Cluster porosity

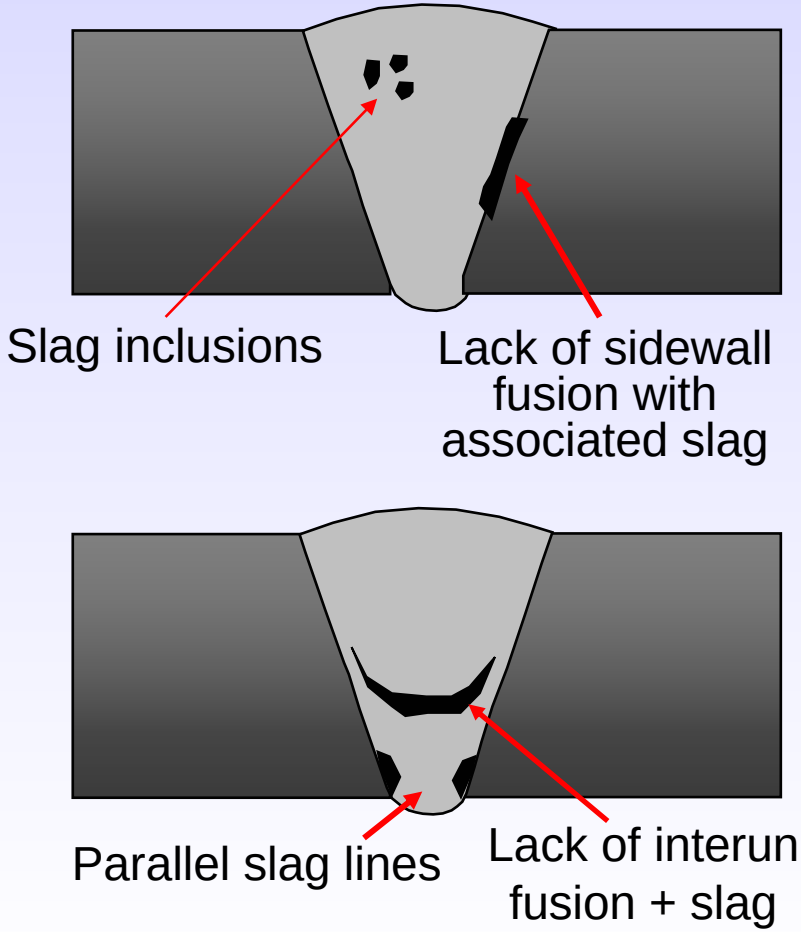




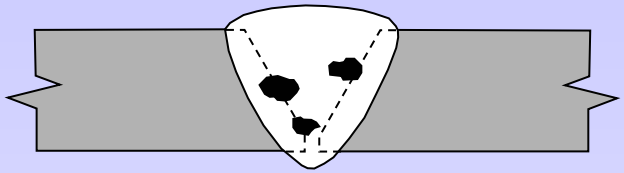
Herring bone porosity

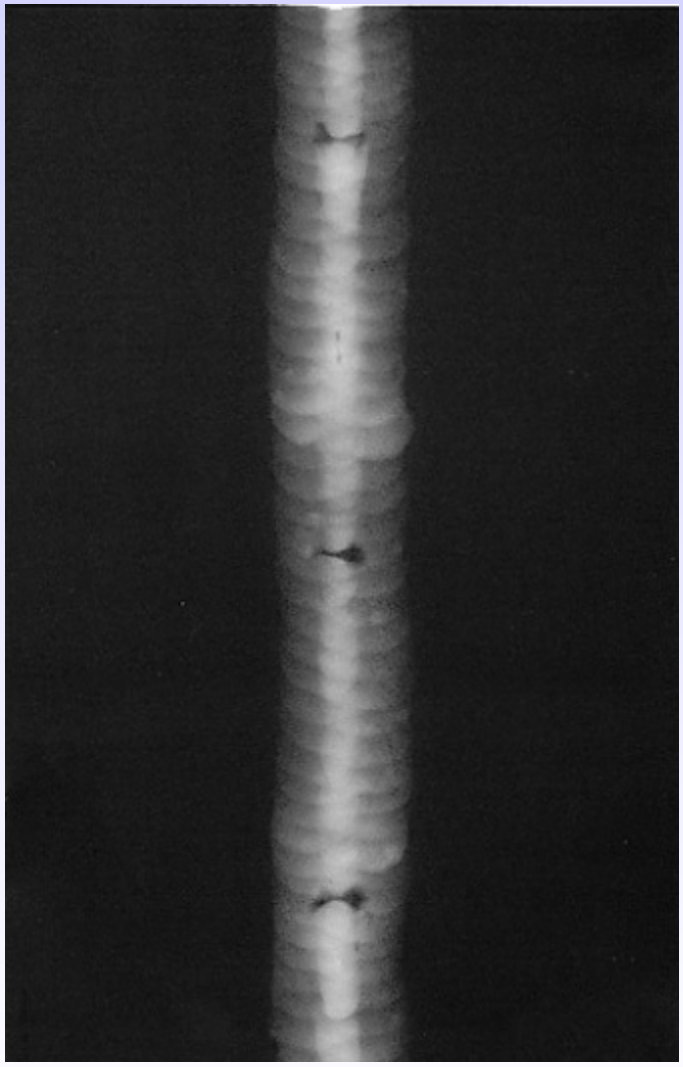
# Solid Inclusions

*Slag inclusions are defined as a non-metallic inclusion caused by some welding process*

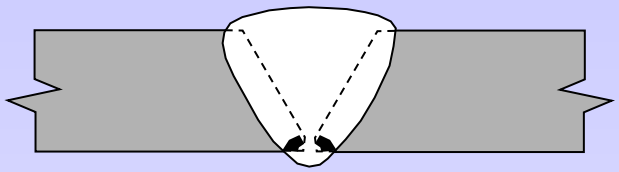


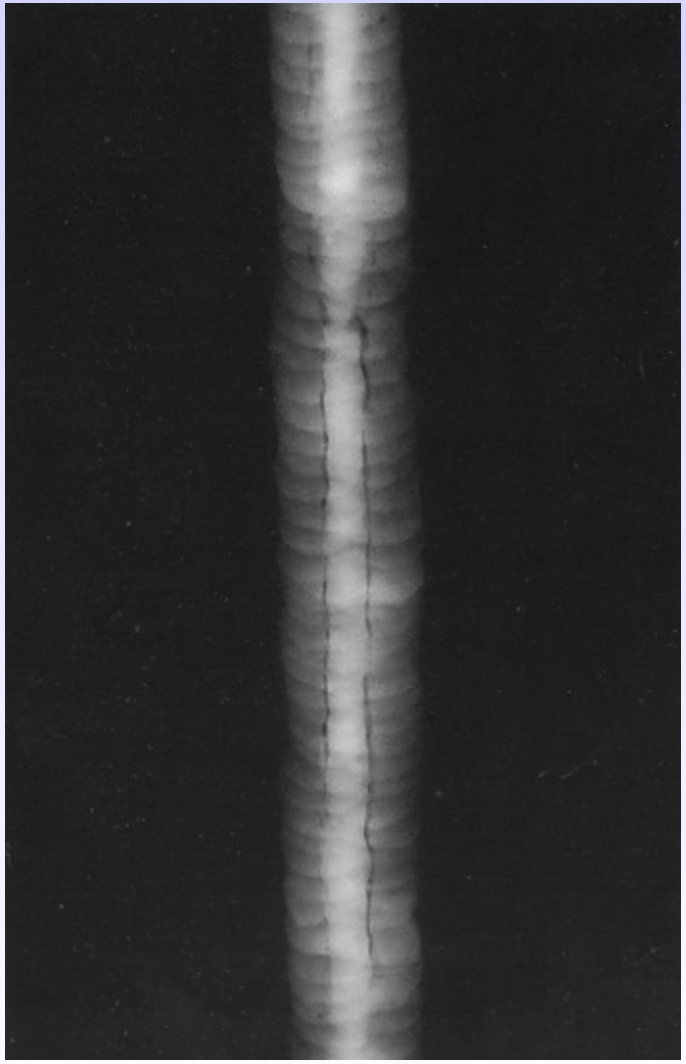

- Slag originates from welding flux
- MAG and TIG welding process produce silica inclusions
- Slag is caused by inadequate cleaning
- Other inclusions include tungsten and copper inclusions from the TIG and MAG welding process





Interpass slag inclusions





Elongated slag lines

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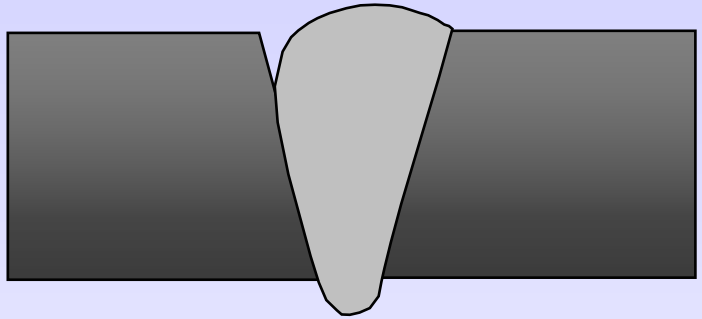
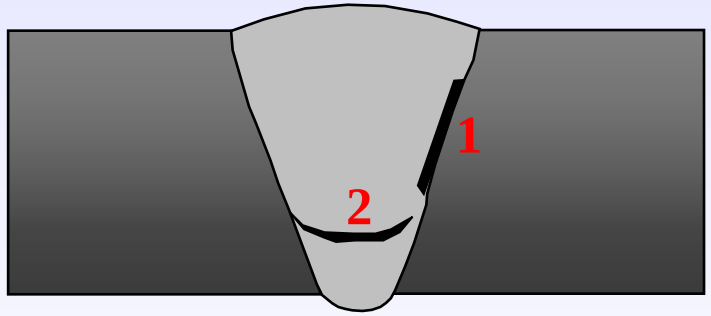
# Lack of Fusion

# Surface and profile Defects.



Incomplete filled groove
+ Lack of sidewall fusion

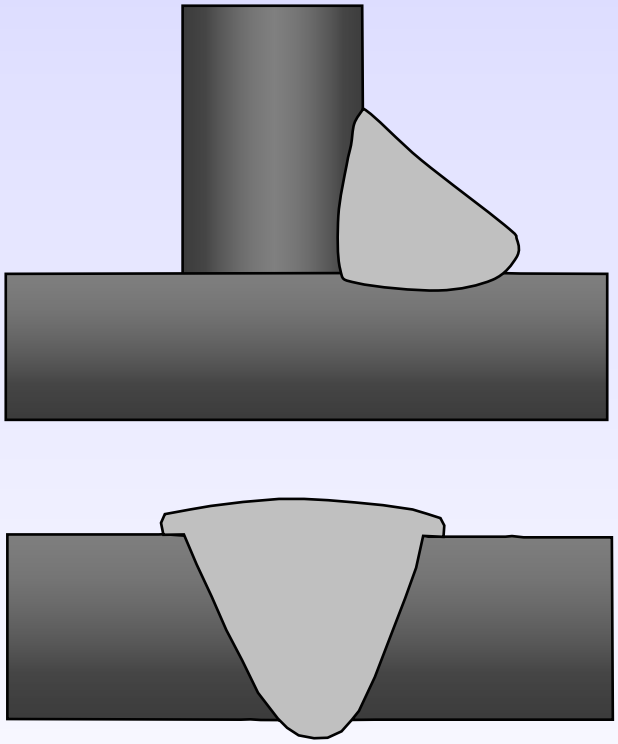



1. Lack of sidewall fusion
2. Lack of inter-run fusion

- Poor welder skill
- Incorrect electrode manipulation
- Arc blow
- Incorrect welding current/voltage
- Incorrect travel speed
- Incorrect inter-run cleaning

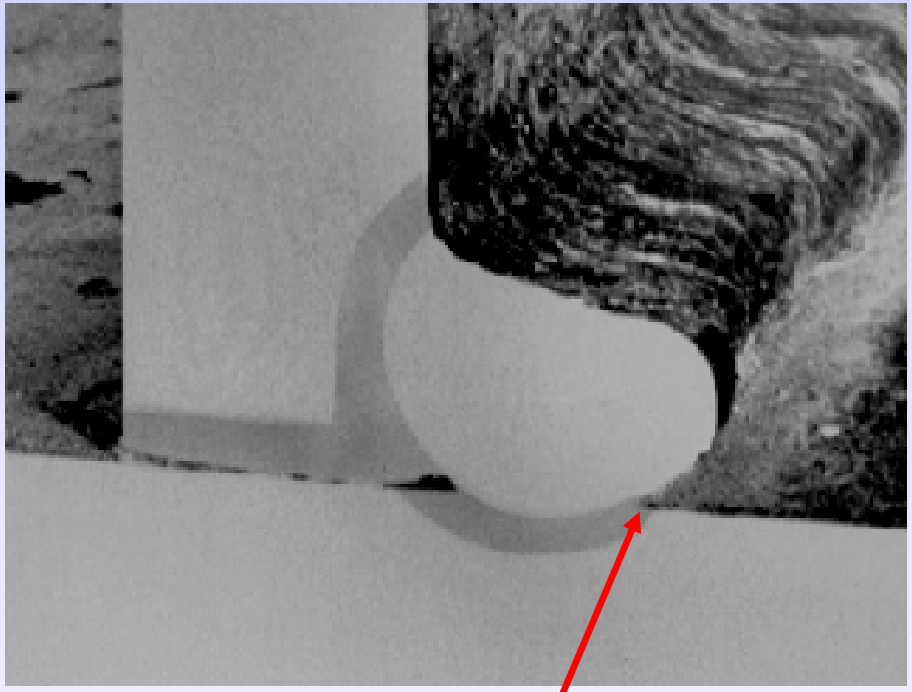
# Overlap

*An imperfection at the toe or root of a weld caused by metal flowing on to the surface of the parent metal without fusing to it*

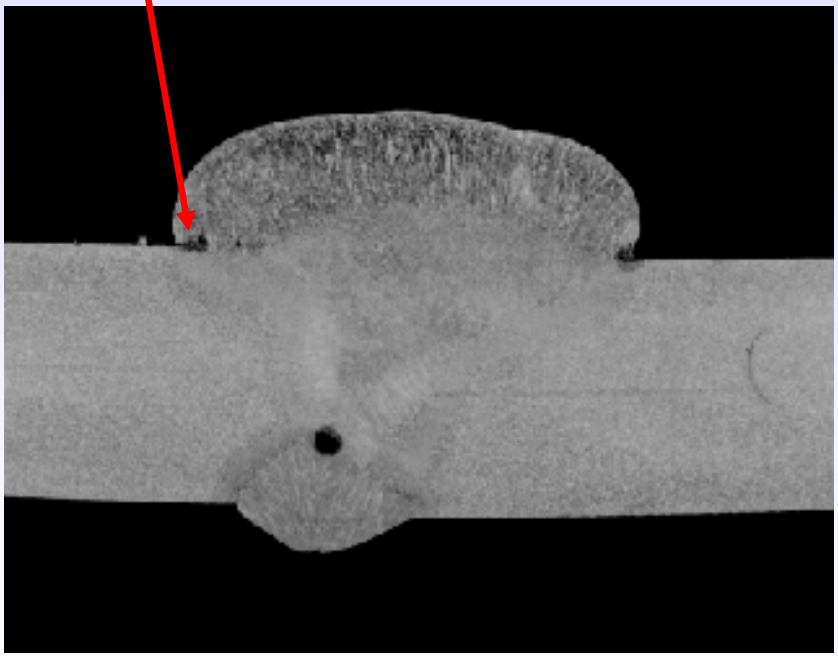


- Contamination
- Slow travel speed
- Incorrect welding technique
- Current too low

# Overlap

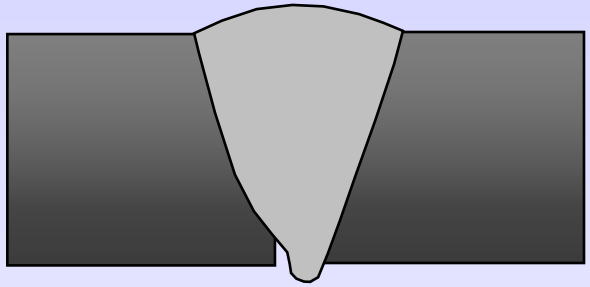


Toe Overlap
Butt weld

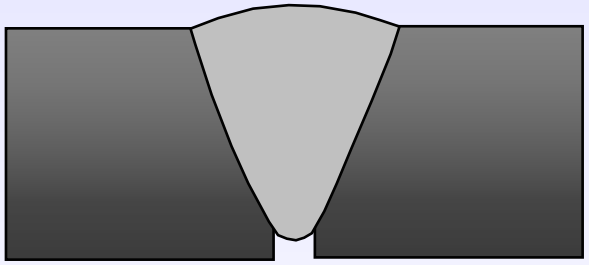


Toe Overlap
Fillet weld

# Root Defects



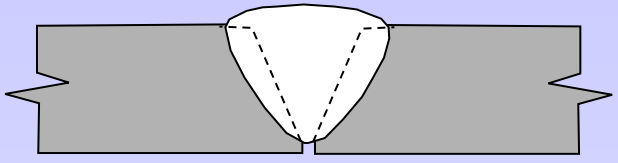
Incomplete root fusion

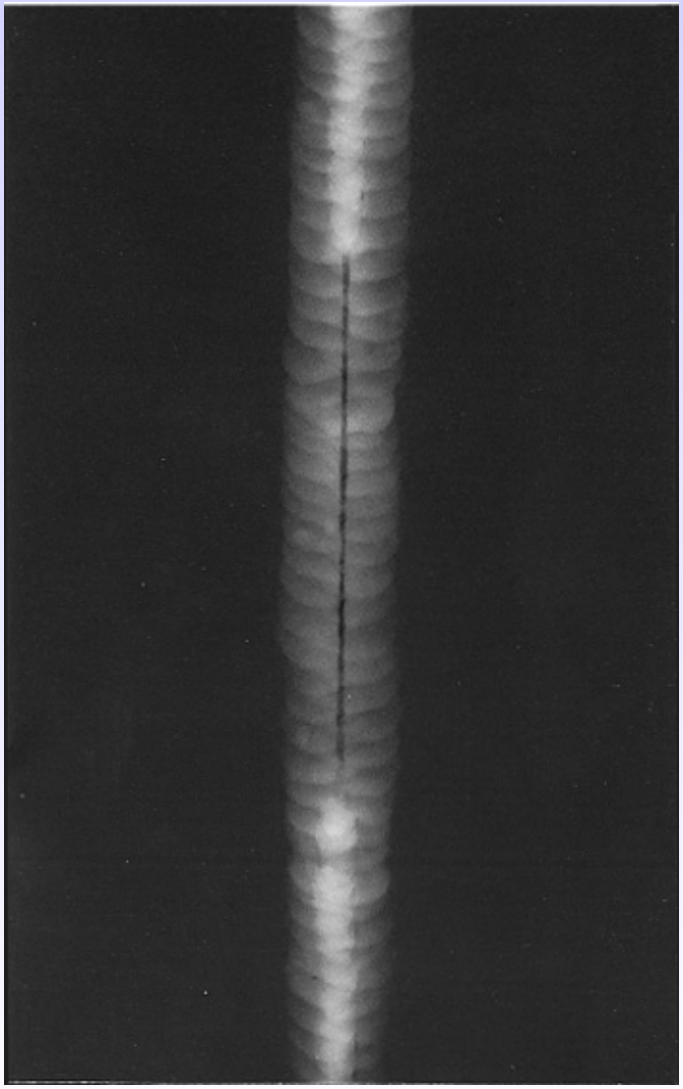


Incomplete root penetration

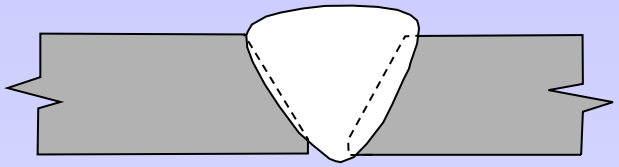
- Low Amps/volts
- Large Root face
- Small Root Gap
- Fast Travel Speed
- Incorrect Electrode Angle
- Contamination
- Arc blow

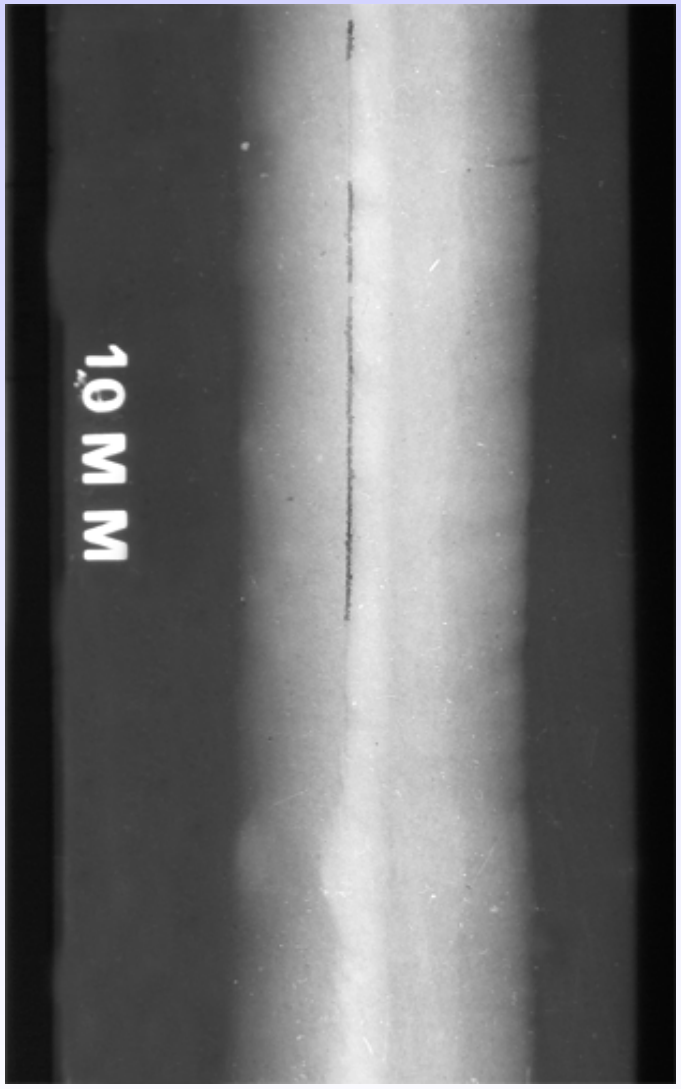
# Root Defects





Lack of root penetration






Lack of root fusion

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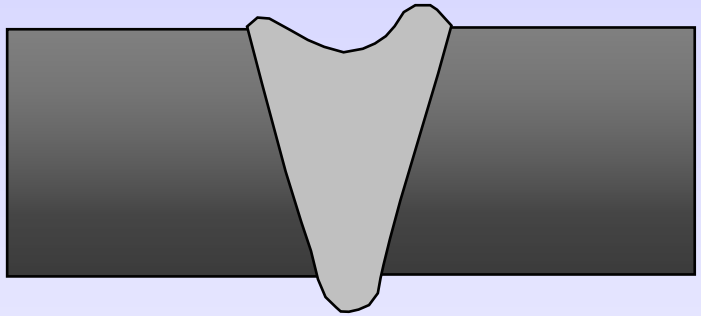
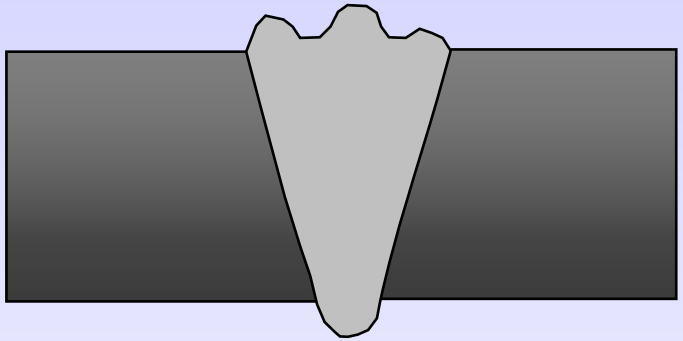
# Surface and Profile

# Profile Defects

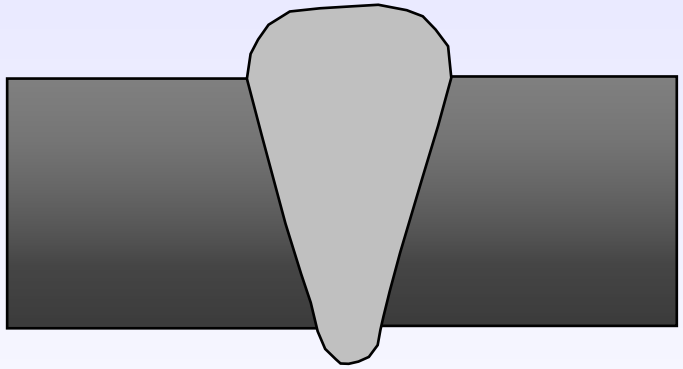


Incomplete filled groove

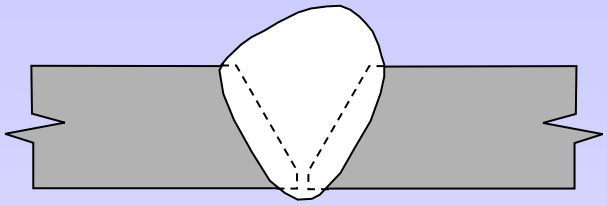


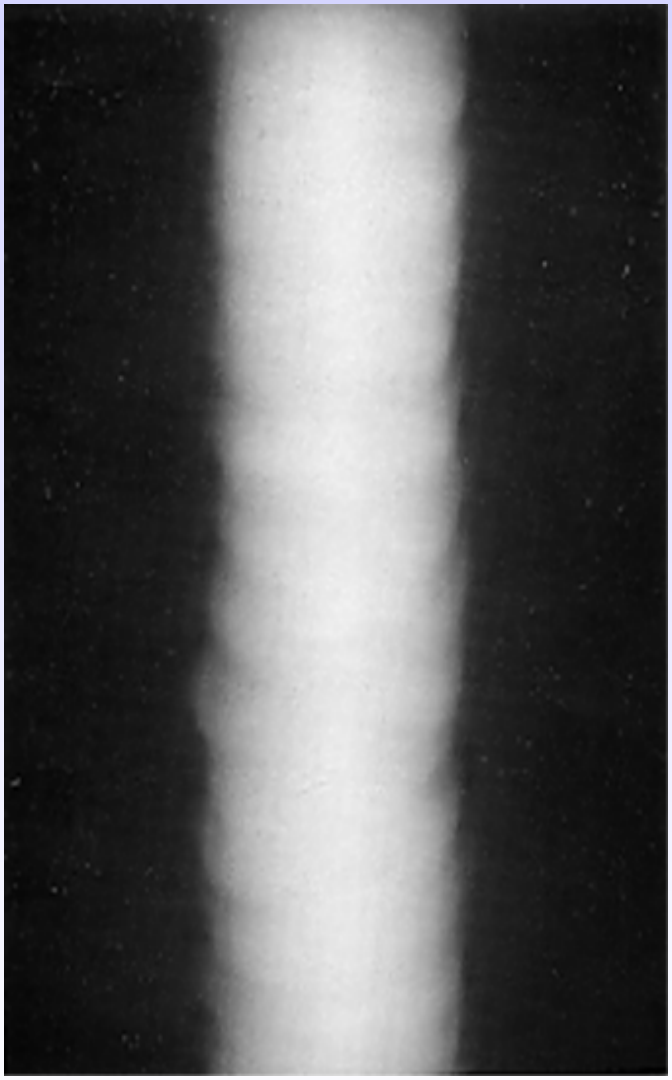
Poor cap profile

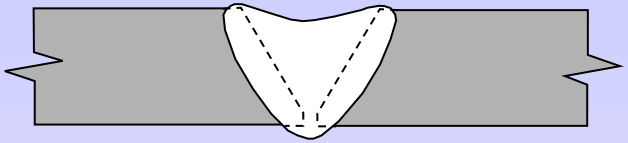
Poor cap profiles and excessive cap reinforcements may lead to stress concentration points at the weld toes and will also contribute to overall poor toe blend

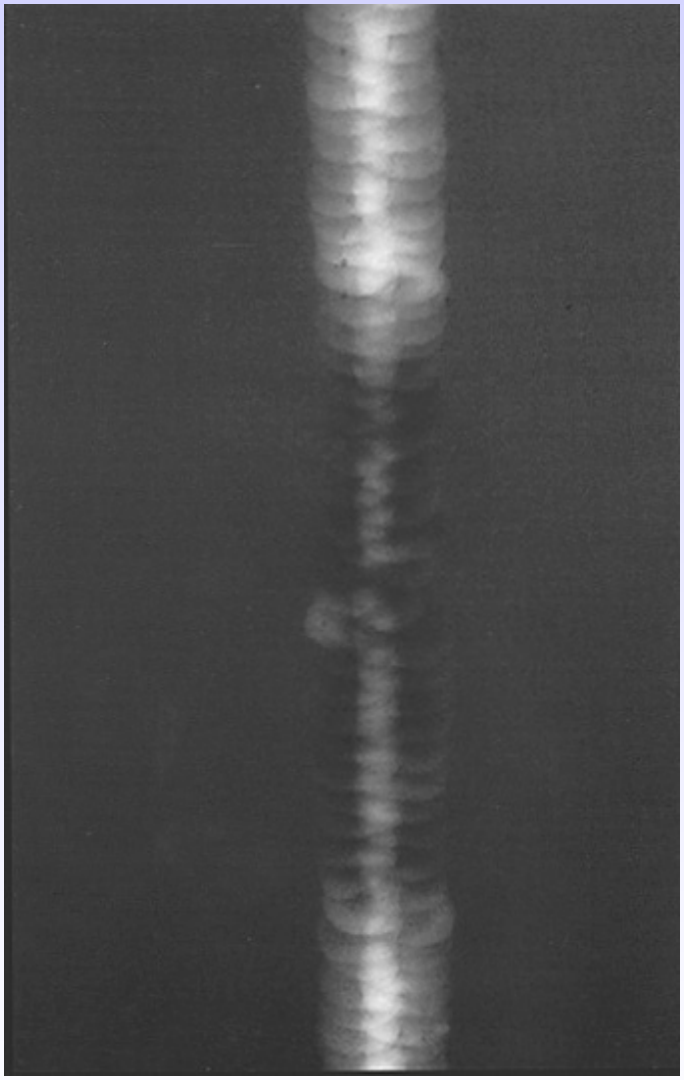


Excessive cap height







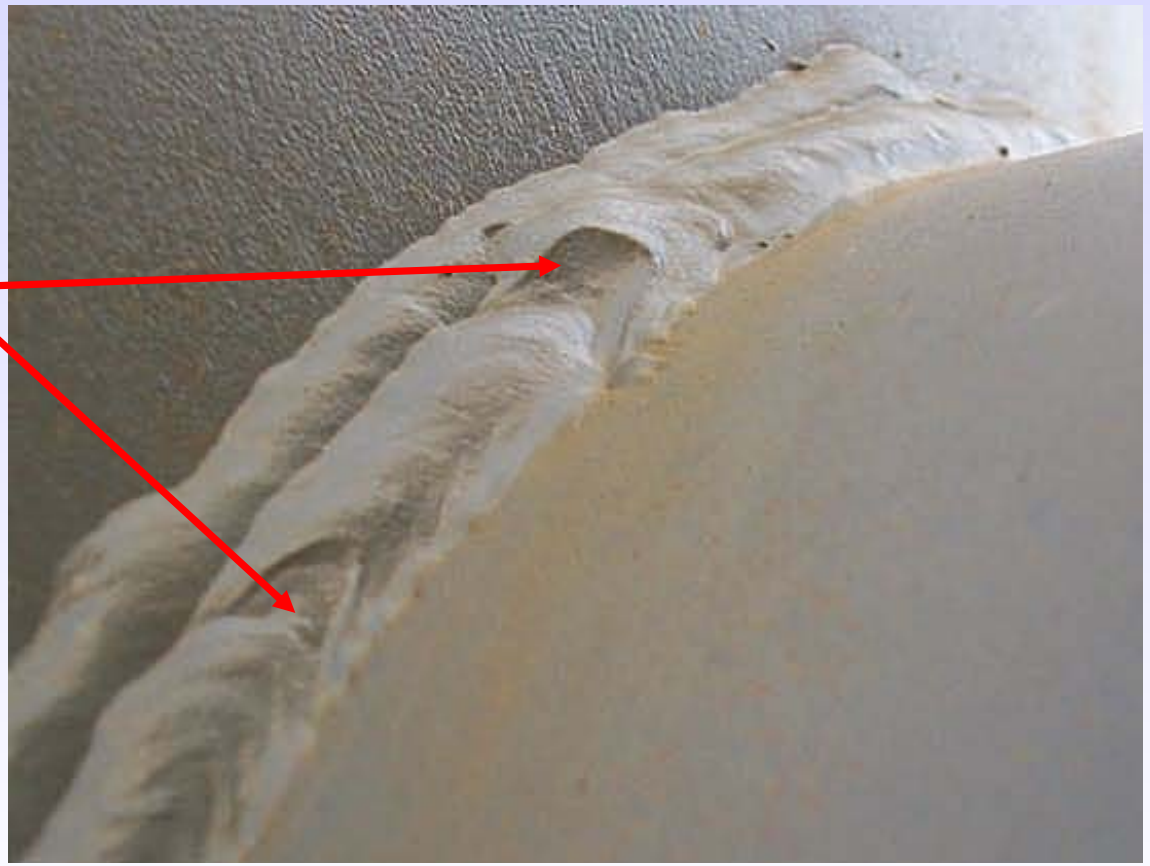


**Excess cap reinforcement**

**Incomplete filled groove**

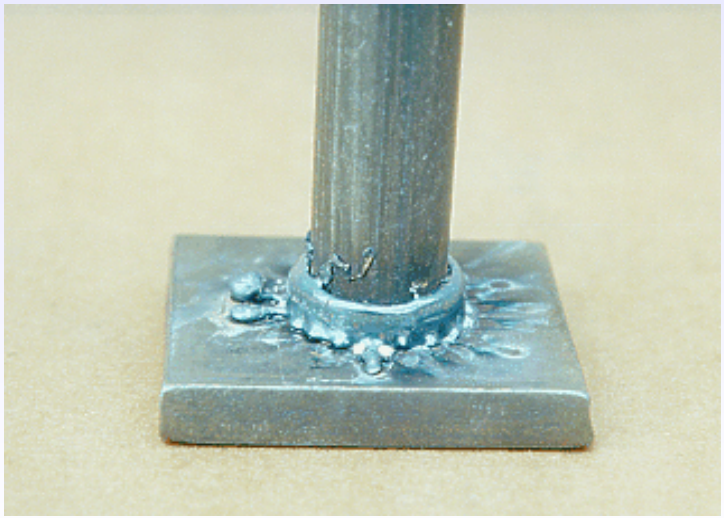
# Profile Defects

Poor stop/starts



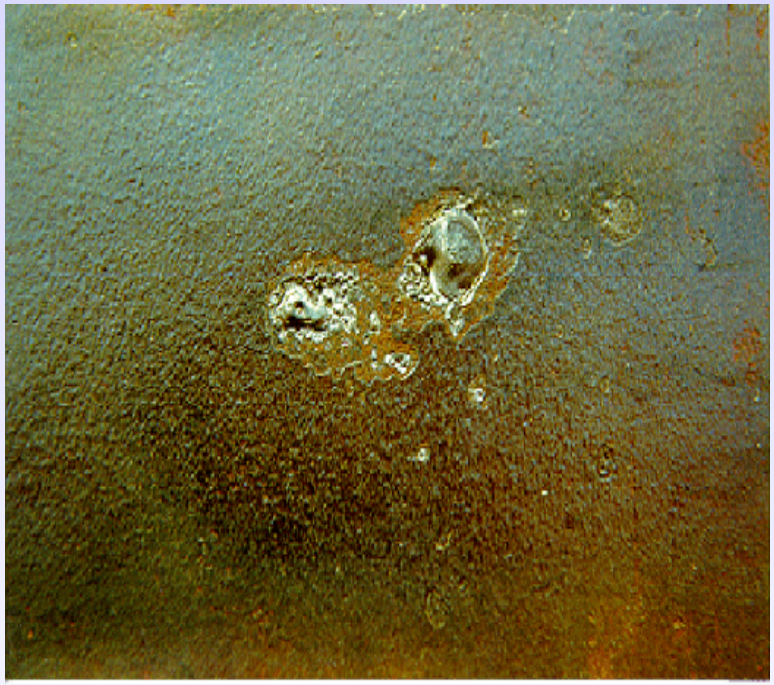
# Miscellaneous Defects

**Spatter**



- Excessive current
- Damp electrodes
- Contamination
- Incorrect wire feed speed when welding with the MAG welding process
- Arc blow

# Miscellaneous Defects

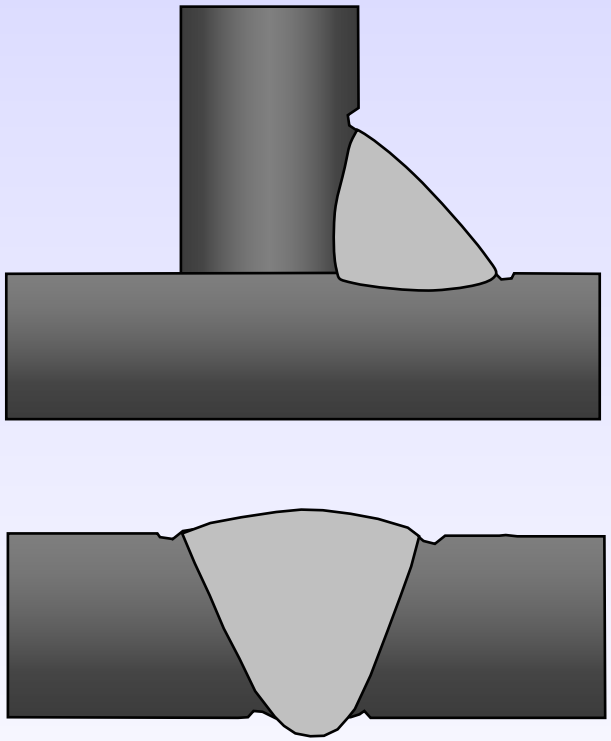


**Arc strike**

- Accidental striking of the arc onto the parent material
- Faulty electrode holder
- Poor cable insulation
- Poor return lead clamping

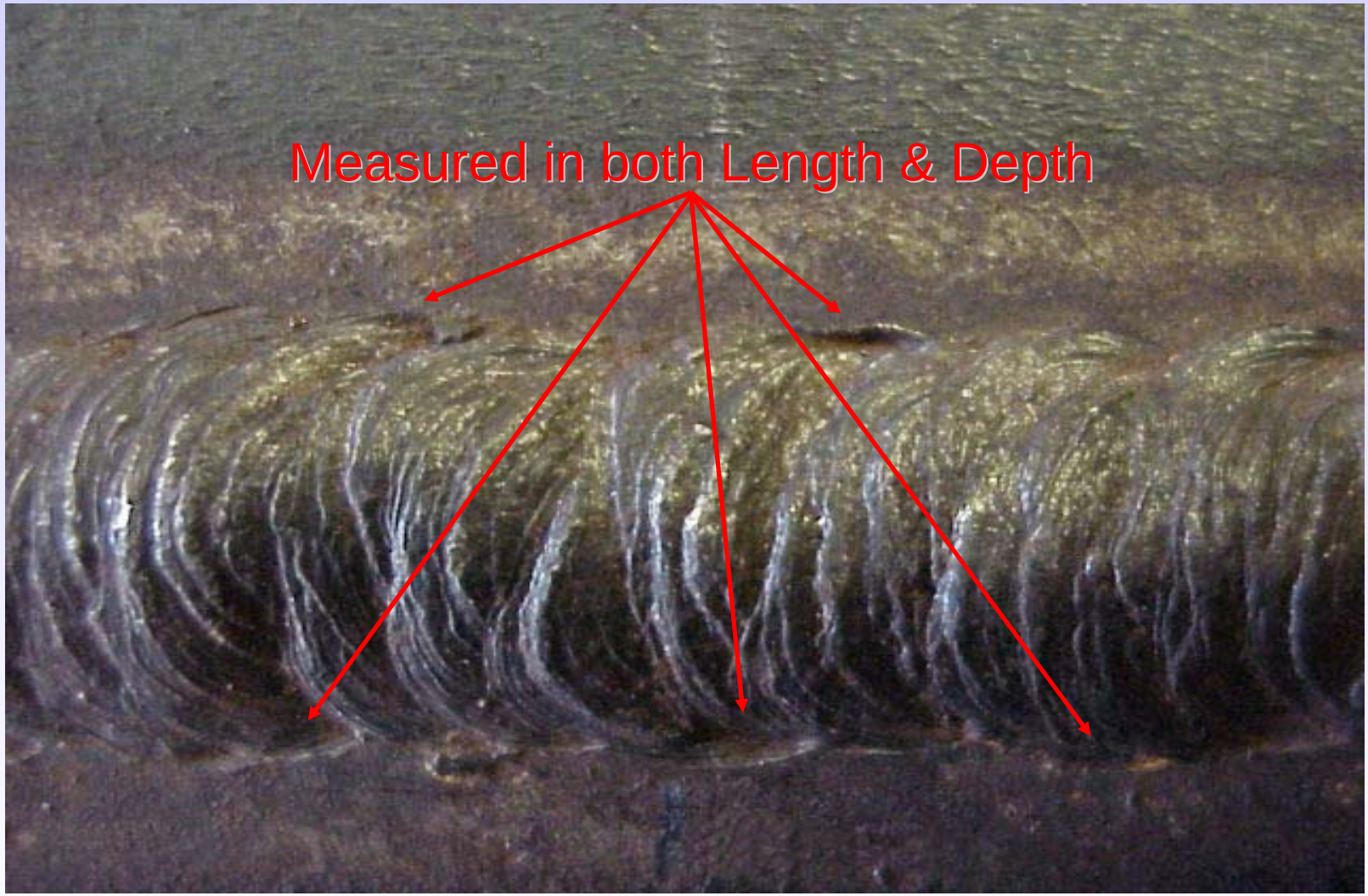
# Undercut.

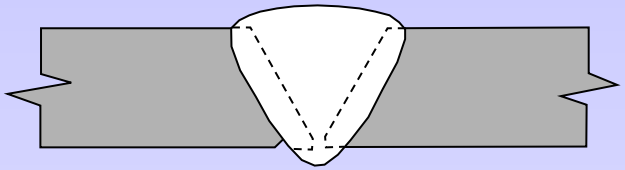
*An irregular groove at the toe of a weld run in the parent metal*

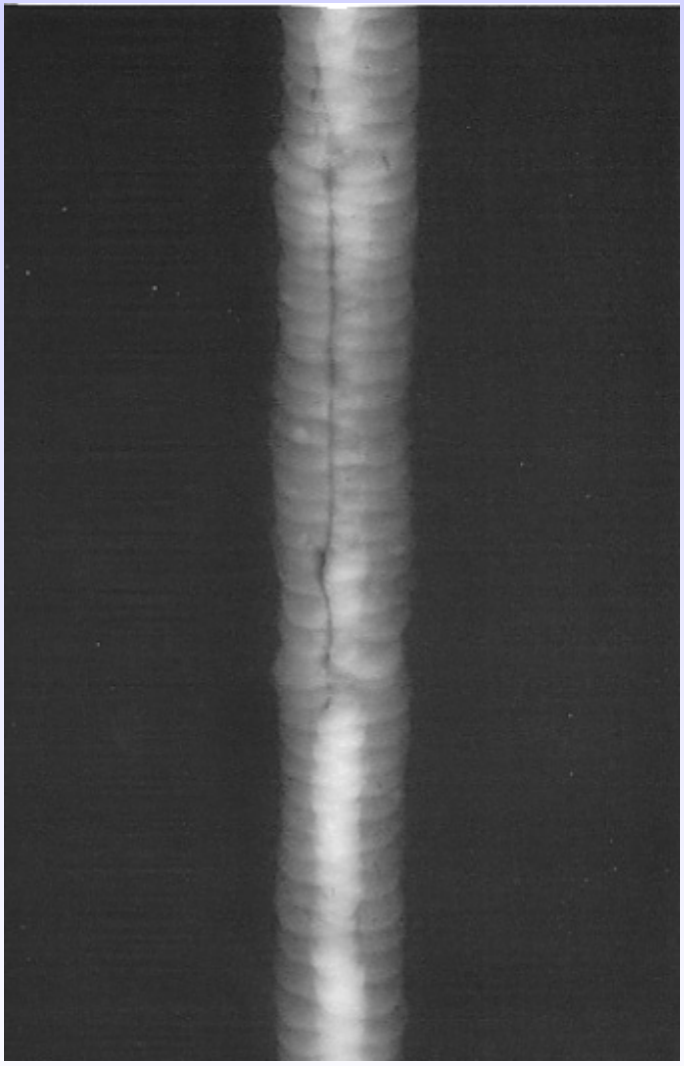


- Excessive amps/volts
- Excessive travel speed
- Incorrect electrode angle
- Excessive weaving
- Incorrect welding technique
- Electrode too large

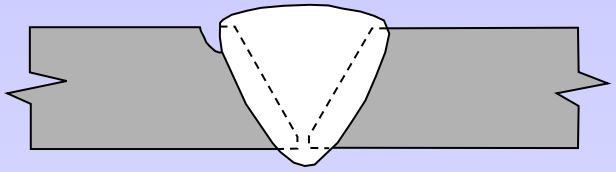
# Cap Undercut

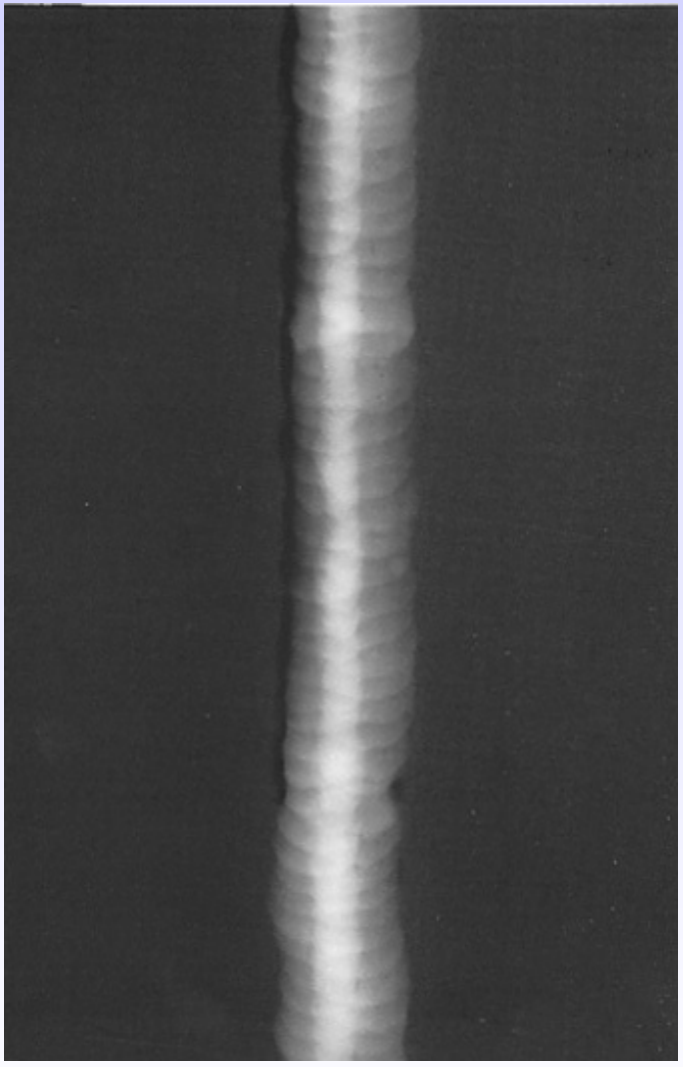






**Root undercut**

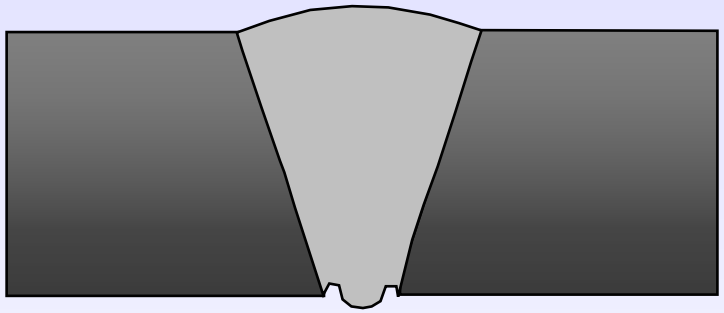




**Cap undercut**

# Shrinkage Groove

*A shallow groove caused by contraction in the weld metal along each side of the penetration bead*

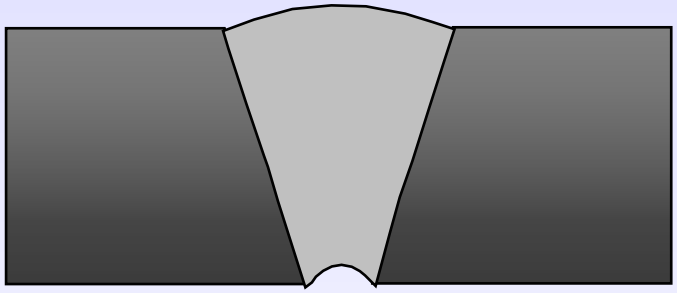


Shrinkage groove

- Insufficient weld metal deposited in the root pass
- Too fast a cooling rate during the application of the root bead pass
- Poor welding technique

# Concave Root

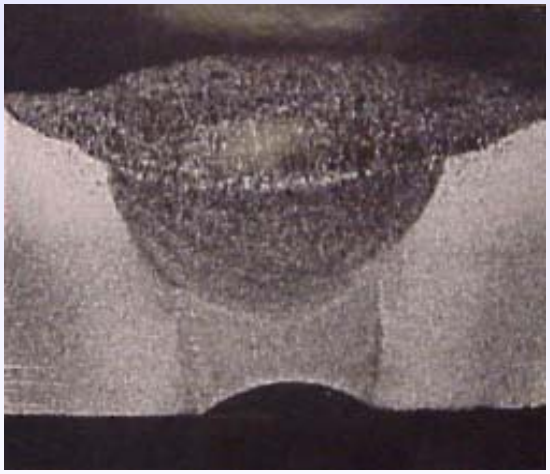
*A shallow groove, which may occur in the root of a butt weld*



Concave root

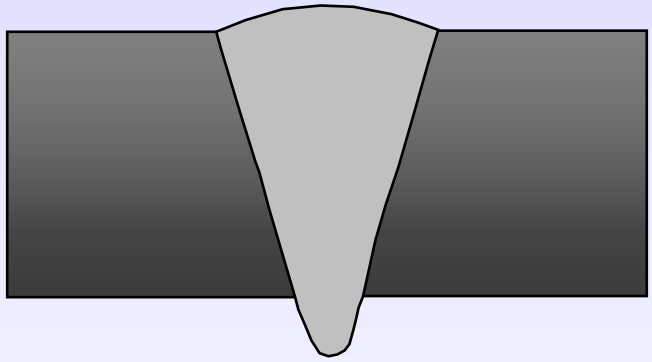
- Root faces too large
- Root gap too large
- Excessive back purge pressure during TIG welding
- Excessive root bead grinding before the application of the second pass

# Concave Root

# Excessive Root Penetration

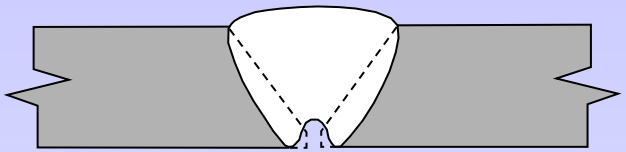
*Root penetration bead in excess in accordance with the relevant specification being used*



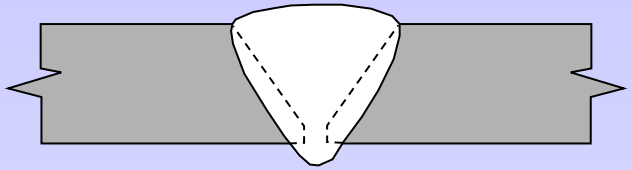
Excessive root penetration

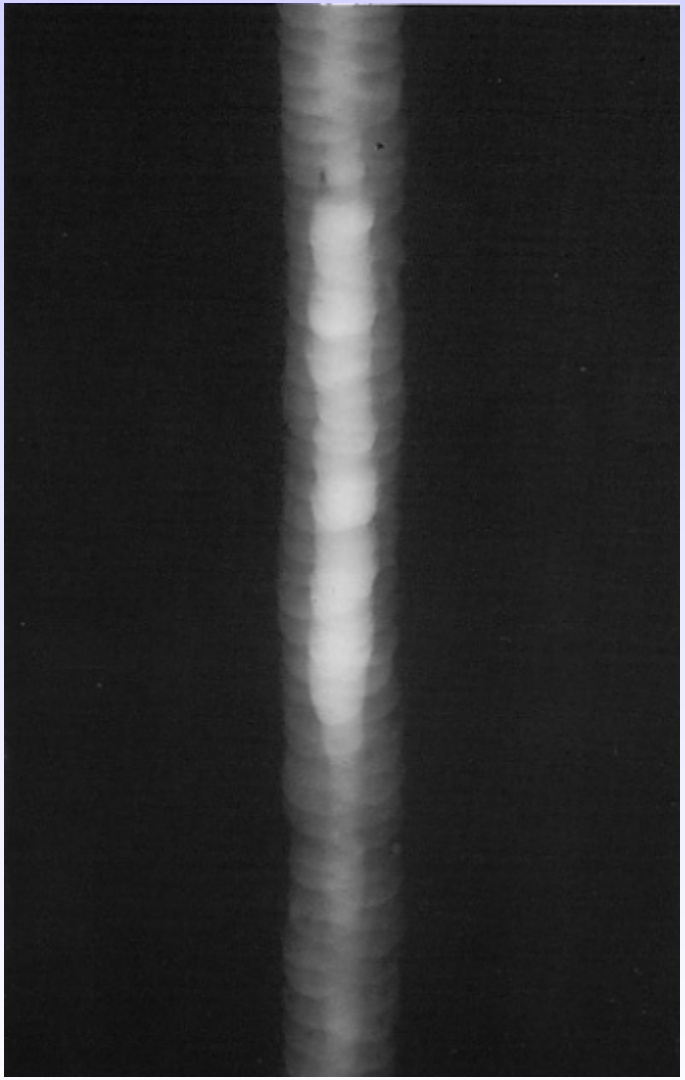
- Root faces too small
- Root gap too large
- Excessive amps/volts
- Slow travel speed

# Excessive Root Penetration



Concave root

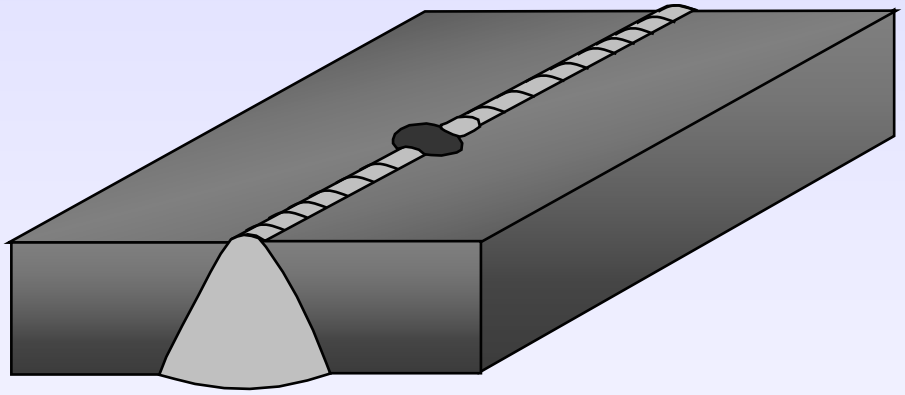




Excessive root penetration

# Burn Through

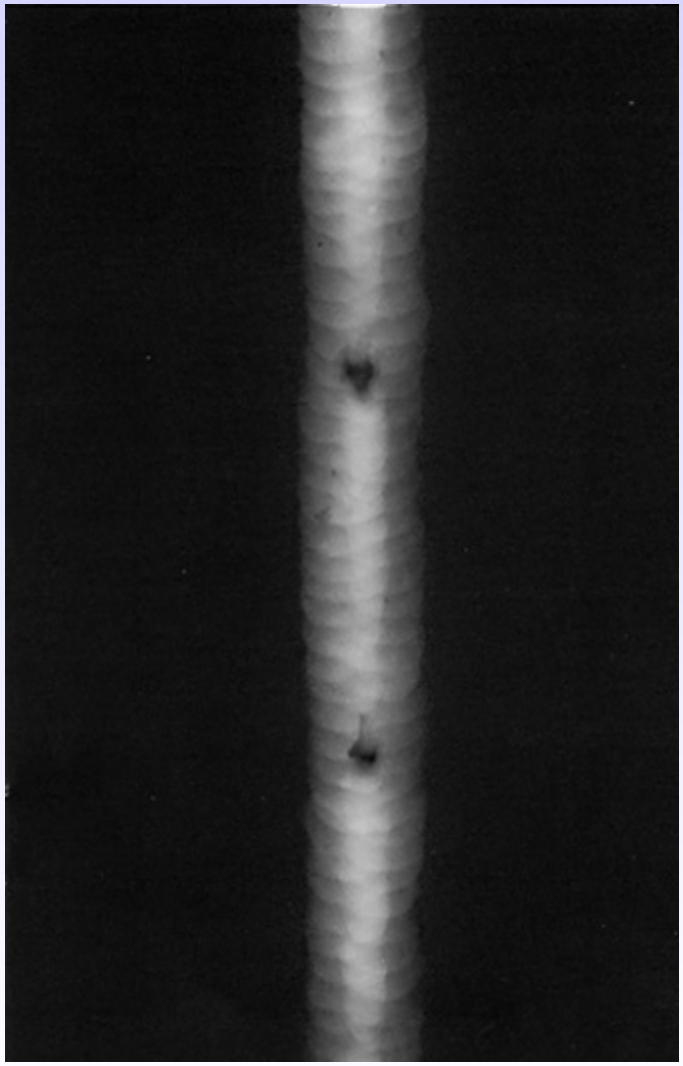
*A localized collapse of the weld pool due to excessive penetration resulting in a hole in the root run*



Burn through

- High Amps/volts
- Small Root face
- Large Root Gap
- Slow Travel Speed

# Burn Through

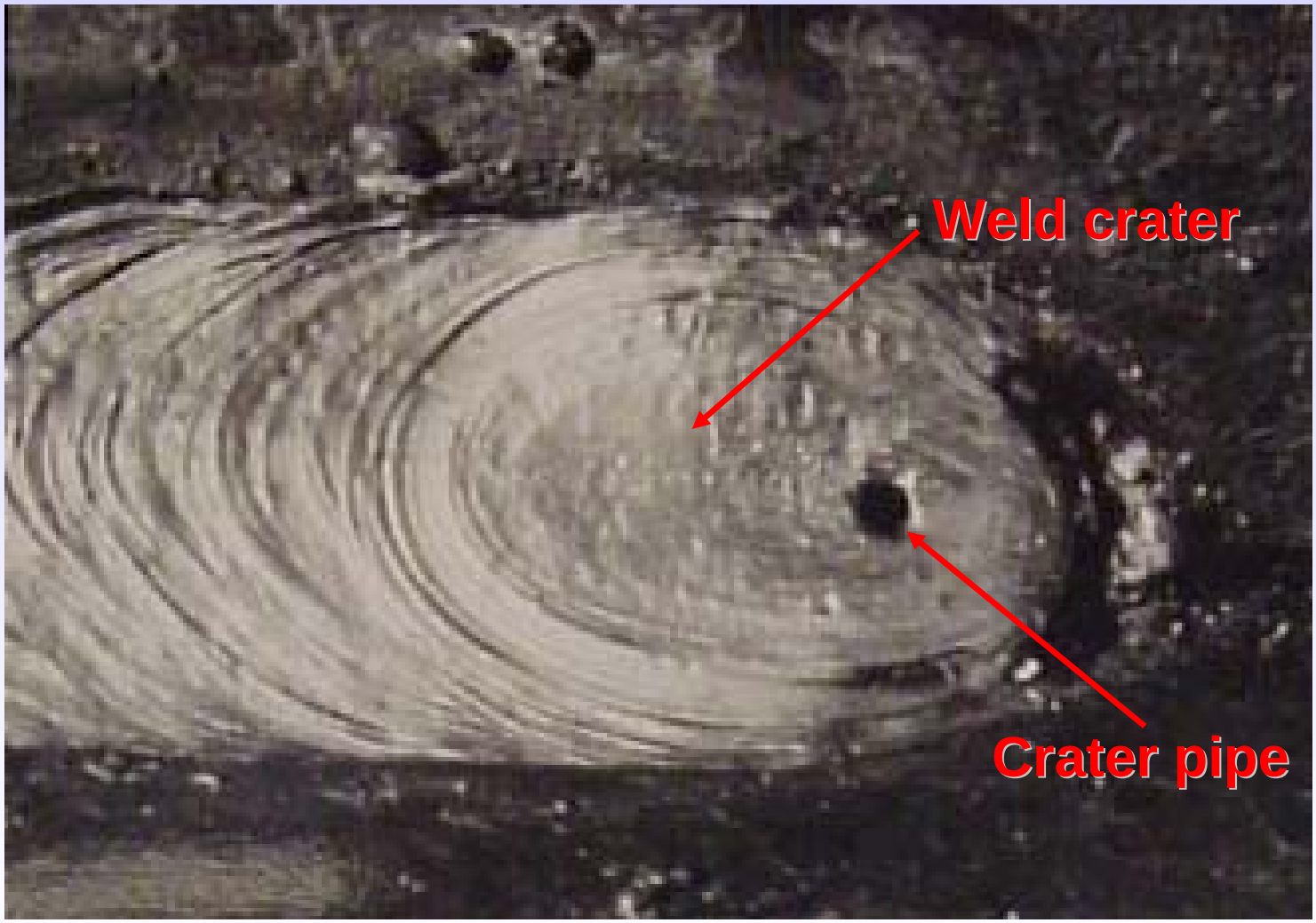
Burn through

# Root Coking~Oxidized Root.



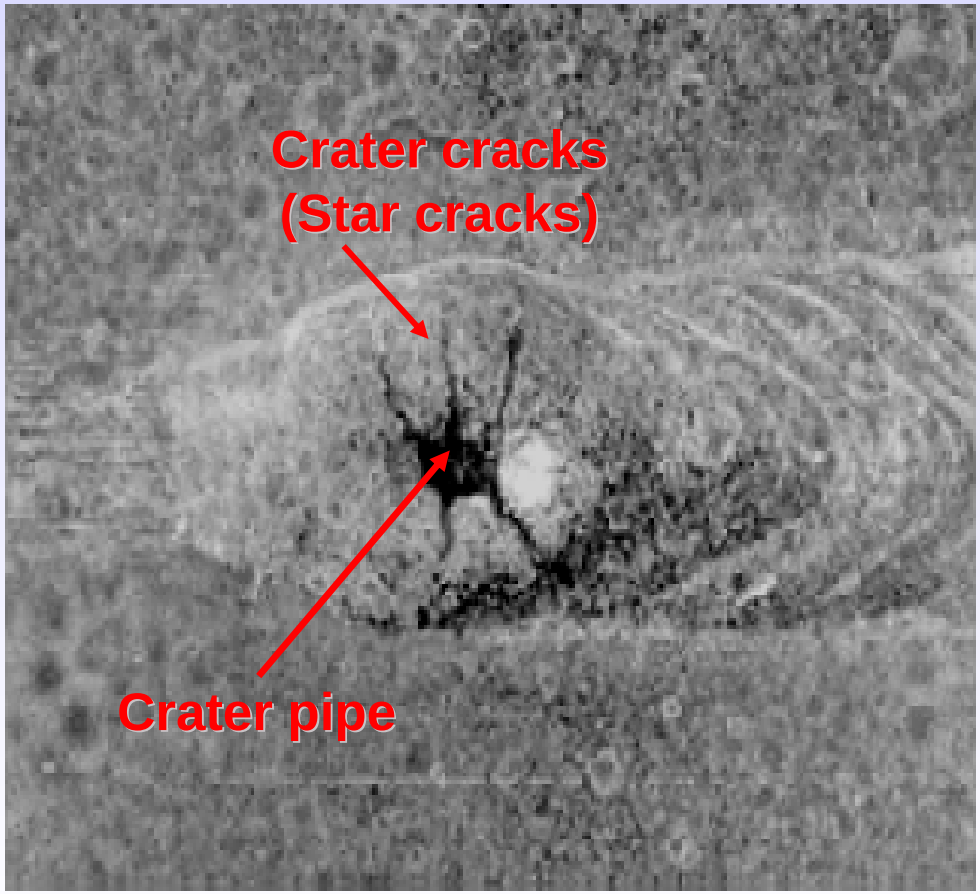
- Loss or insufficient back purging gas
- Most commonly occurs when welding stainless steels
- Purging gases include argon, helium and occasionally nitrogen

# Crater Pipe



# Crater Pipe

*Crater pipe is a shrinkage defect and not a gas defect, it has the appearance of a gas pore in the weld crater*




- Too fast a cooling rate
- Deoxidization reactions and liquid to solid volume change
- Contamination

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TECHNOLOGY

# Mechanical Damage

# Mechanical Damage

Mechanical damage can be defined as any surface material damage cause during the manufacturing process.
This can included damage caused by:

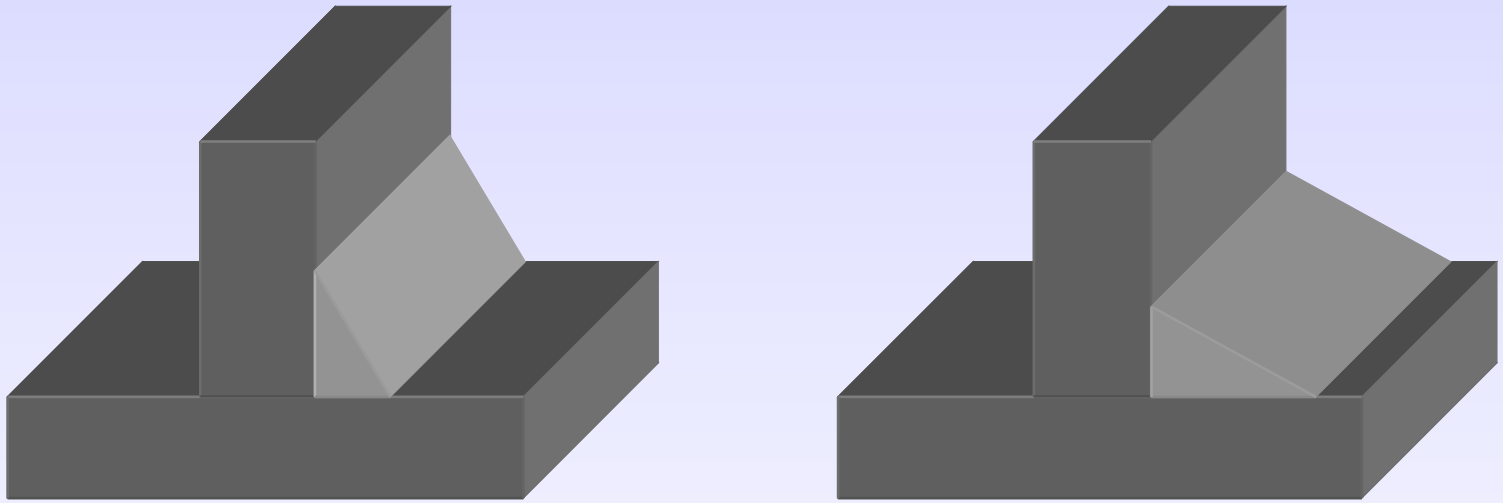
- Grinding
- Hammering
- Chiselling
- Chipping
- Breaking off welded attachments (torn surfaces)
- Using needle guns to compress weld capping runs

TECHNOLOGY

# Set~up Irregularitie

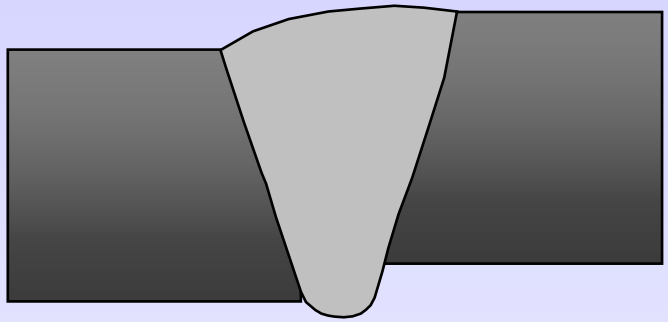
# Unequal Leg Lengths

A variation of leg lengths on a fillet weld



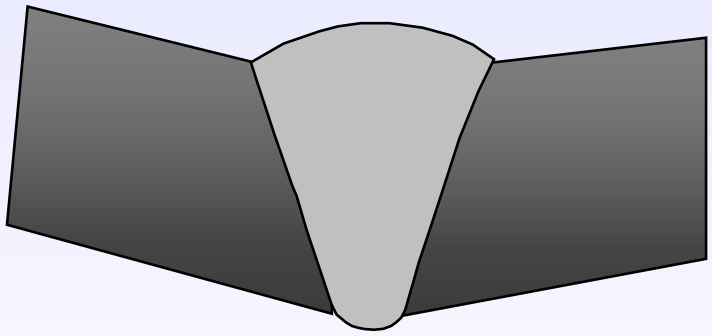
Note: Unequal leg lengths on a fillet weld may be specified as part of the design, in which case it will not be considered as a defect.

# Set˜up Irregularities.



Plate/pipe Linear Misalignment (Hi-Lo)

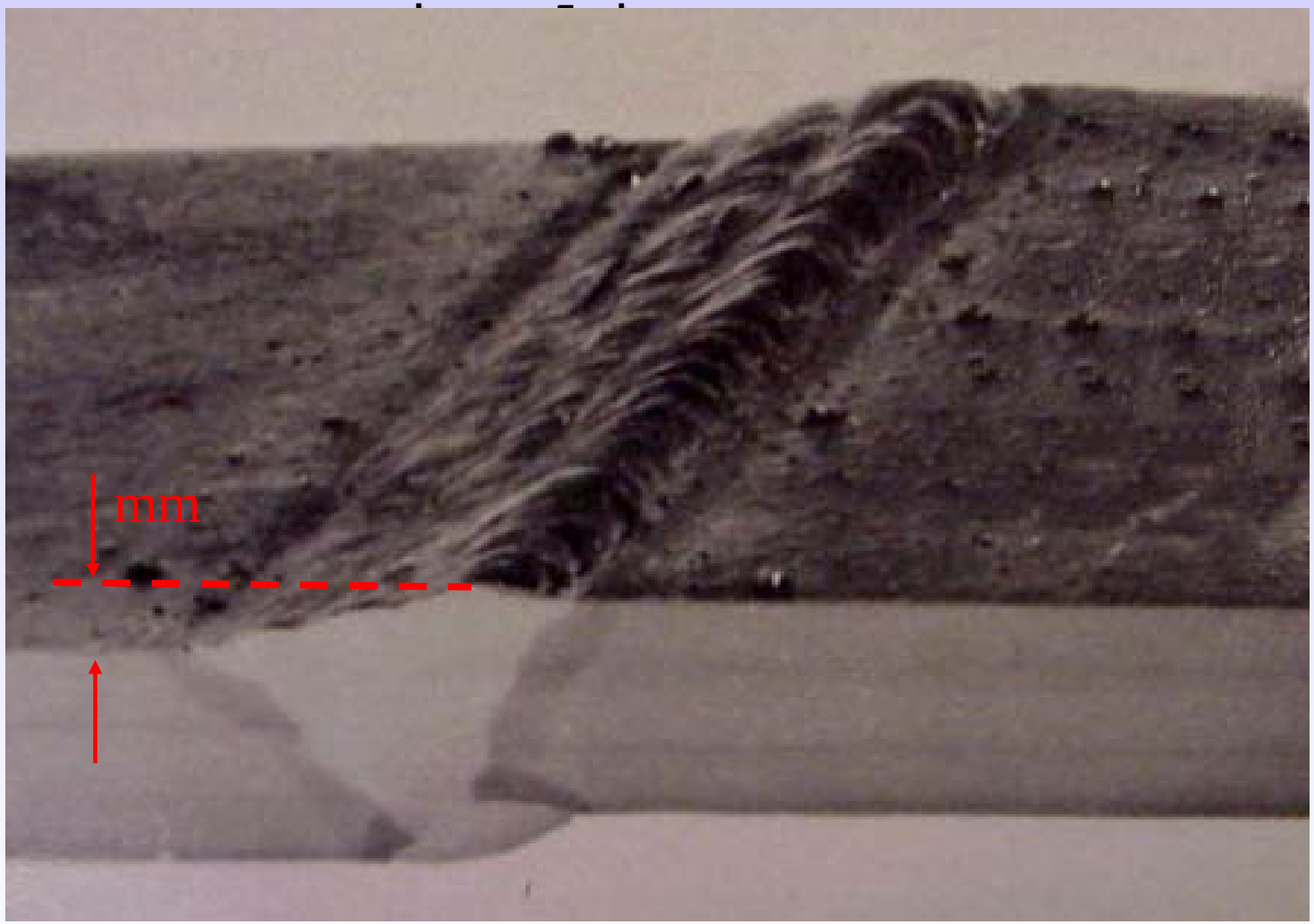
Linear misalignment is measured from the lowest plate to the highest point of the cap



Angular Misalignment

Angular misalignment is measured in degrees

# Linear



# Any Questions

# Questions

QU 1. Give two main causes for the occurrence of a burn through

QU 2. Give two main causes for the occurrence of excessive root penetration on a single-V butt weld

QU 3. Give five defects, which may occur when welding carbon steel using the MMA welding process with the current setting to low

QU 4. Give three possible causes for the occurrence of lack of side wall fusion

QU 5. Sketch the following defects

a. Lack of root wall fusion b. Lack of root penetration

c. Incomplete filled groove d. Concave root

TECHNOLOGY

# Materials Inspection

# Material Inspection

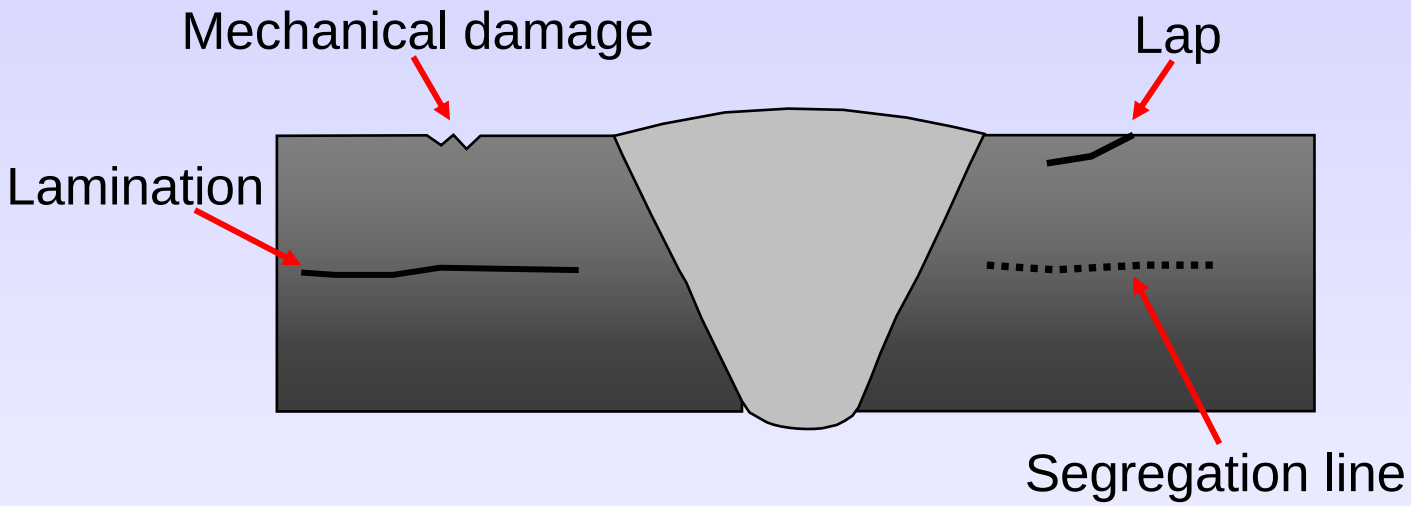
All materials arriving on site should be inspected for:

- Size / dimensions
- Condition
- Type / specification

In addition other elements may need to be considered depending on the materials form or shape

# Parent Material Defects

## Parent material defects include:

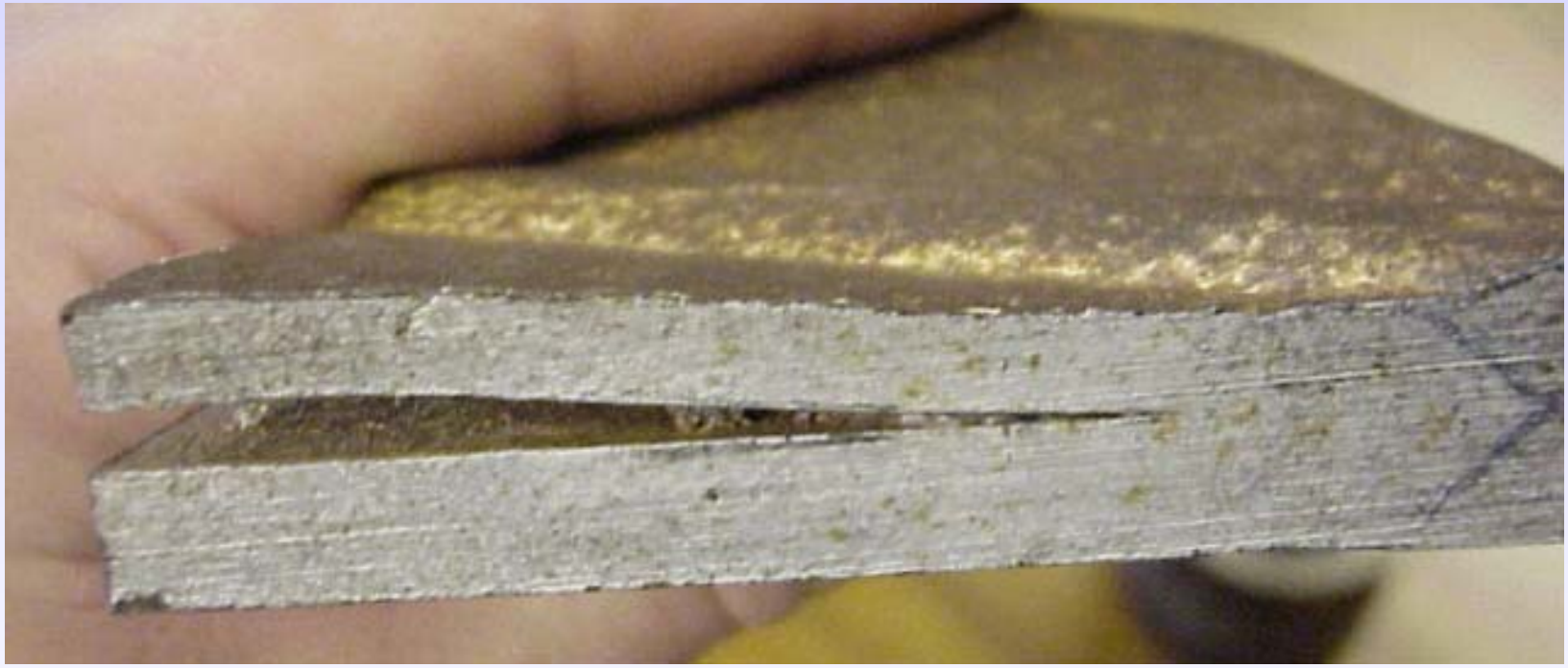



**Laminations** are caused in the parent plate by the steel making process, originating from ingot casting defects.

**Segregation bands** occur in the centre of the plate and are low melting point impurities such as sulphur and phosphorous.

**Laps** are caused during rolling when overlapping metal does not fuse to the base material.

# Plate Lamination



TECHNOLOGY

# Weld Repairs

# Welding Repairs

## In the event of repair

- Authorization for repair
- Removal and preparation for repair
- Testing of repair - visual and NDT

# Weld Repairs

- A weld repair may be used to improve weld profiles or extensive metal removal
- Repairs to fabrication defects are generally easier than repairs to service failures because the repair procedure may be followed
- The main problem with repairing a weld is the maintenance of mechanical properties
- During the inspection of the removed area prior to welding the inspector must ensure that the defects have been totally removed and the original joint profile has been maintained as close as possible

# Weld Repairs

The specification or procedure will govern how the defective areas are to be removed. The method of removal may be

- Grinding
- Chipping
- Machining
- Filing
- Oxy-Gas gouging
- Arc air gouging

# Any Questions

# Questions

QU 1. State six points of importance of repair welding.

QU 2. State two NDT methods that may be applied to a repair in a weld

QU 3. State three documents, which the inspector should refer to when carrying out repairs.

QU 4. In some cases why might a specification not allow a crack to be repaired, regardless of size and orientation?