



## آزمون فراصوتی Ultrasonic Testing (UT)

### بازرسی جوش

مدرس: دکتر فرهنگ هنزور  
گروه ساخت و تولید  
دانشکده مهندسی مکانیک  
دانشگاه صنعتی خواجه نصیرالدین طوسی



## Weld Discontinuities

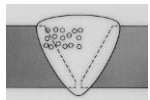
1. **Design related:** e.g. choice of wrong type of weld joint, problem with design of structural details, etc.
2. **Weld process:** e.g. porosity, undercut, slag inclusion, overlap, lack of fusion (LOF), spatter, etc.
3. **Metallurgical:** e.g. cracks, fissures, fisheye, segregation, etc.



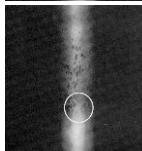
## Weld Defects



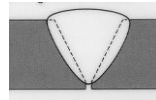
- **Lack of Sidewall Fusion** is seen as elongated parallel or single darker density lines, sometimes with darker density spots.
- Generally run in straight lines in the lengthwise direction.



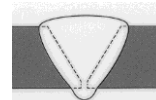
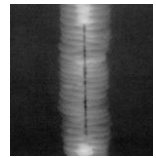
- **Porosity** is easily seen with radiographic testing because of its volumetric nature.
- Rounded and elongated darker density spots in clusters with the clusters randomly spaced.



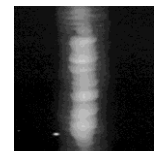
## Weld Defects



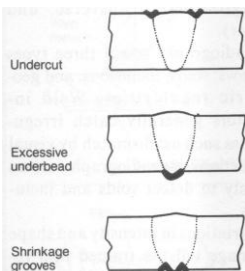
- **Incomplete Penetration** is seen as a darker density band, with very straight parallel edges, in the center of the width of the weld image.



- **Excessive Penetration** is seen as a lighter density in the center of the width of the weld image, either extended along the weld or in isolated circular "drops".



## Typical Weld Defects



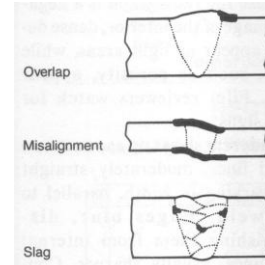
- **Undercut:** A groove melted into the base metal adjacent to the toe or root of a weld and left unfilled by weld metal

- **Shrinkage voids:** Cavity-type discontinuities normally formed by shrinkage during solidification

Reference: Industrial Radiology, Applied Science Publishers



## Typical Weld Defects

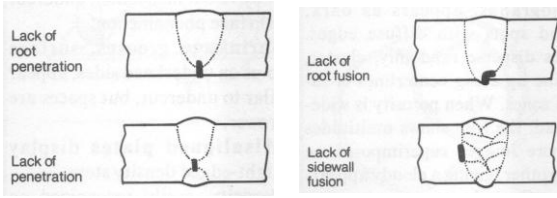


- **Overlap:** The protrusion of weld metal beyond the toe, face, or root of the weld

- **Slag inclusions:** Nonmetallic solid material entrapped in weld metal or between weld metal and base metal

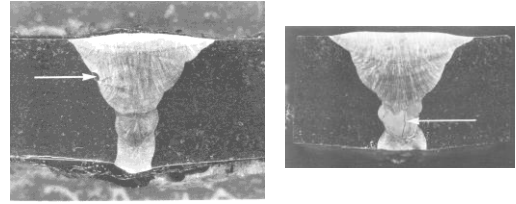
Reference: Industrial Radiology, Applied Science Publishers

## Typical Weld Defects

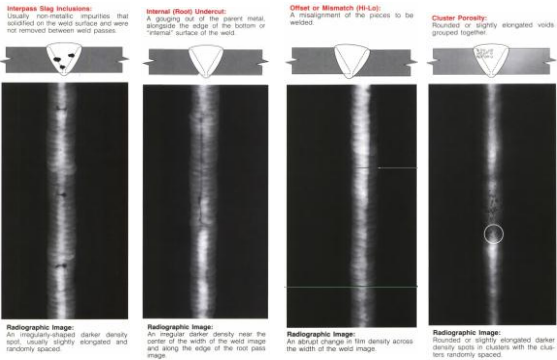


Reference: Industrial Radiology, Applied Science Publishers

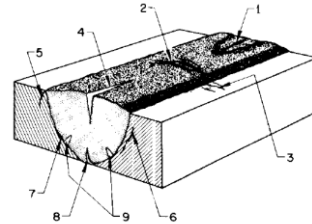
## Typical Weld Defects



## Reference Images – AGFA

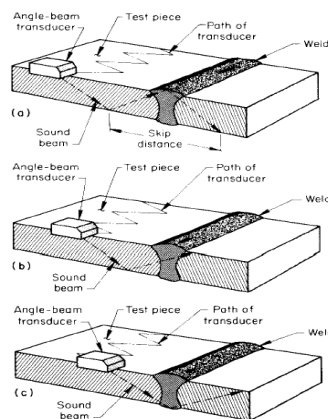
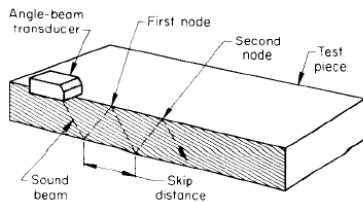


## انواع ترک در جوش



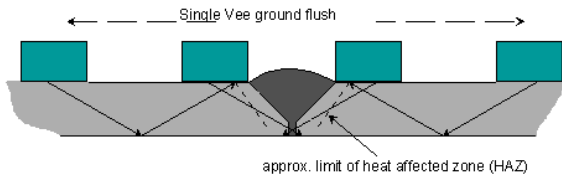
**Fig. 6** Identification of cracks according to location in weld and base metal. 1, crater crack in weld metal; 2, transverse crack in weld metal; 3, transverse crack in HAZ; 4, longitudinal crack in weld metal; 5, toe crack in base metal; 6, underbead crack in base metal; 7, fusion-line crack; 8, root crack in weld metal; 9, hot cracks in weld metal

## بازرسی جوش



بازرسی  
جوش  
به روش  
فراصوتی

## Weld Inspection Techniques

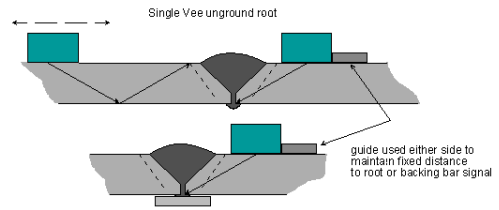


•The single V butt weld, ground flush, permits wide variety in the SW angles for inspection.

•This procedure can be tailored to the weld profile.

Source: Ginzel

## Weld Inspection Techniques



Geometry is a major factor with unground welds, and can severely limit the angles used. The procedure can include guides to help the operator position the transducer correctly for the root.

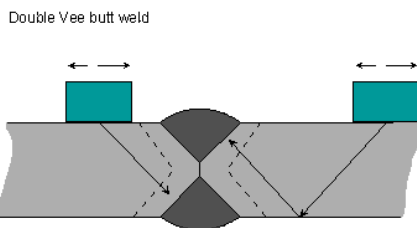
Source: Ginzel

## Weld Inspection Techniques

•Recommended procedure for inspecting double V butt weld.

•Part skip for lower V, and full skip for upper V.

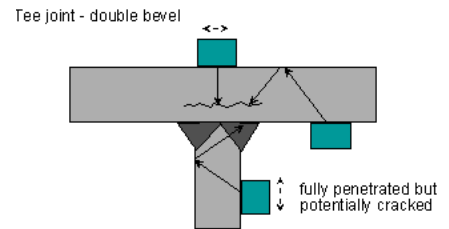
•Angles used depend on weld profile.



Source: Ginzel

## Weld Inspection Techniques

•The double bevel T-joint can be inspected from all sides; fortunately, as the geometry is otherwise not good.

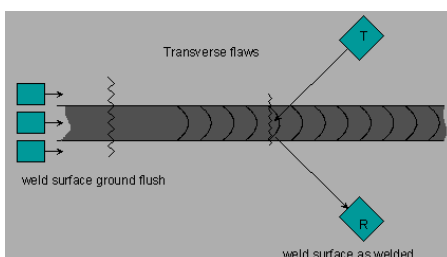


Source: Ginzel

## Weld Inspection Techniques

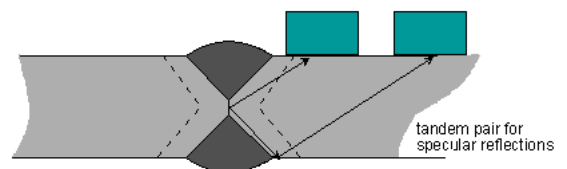
•If the weld is ground flush, transverse defects can be found directly in pulse-echo.

•If not, a pair of transverse transducers can be used in pitch-catch



Source: Ginzel

## Weld Inspection Techniques

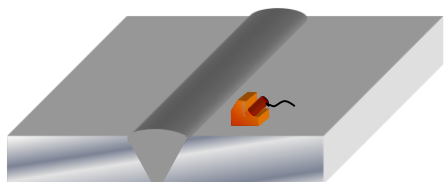


Tandem probes work well for vertical defects, e.g. unfused lands in the centre of a double V. The two transducers must be kept a fixed distance apart for a given depth.

Source: Ginzel

## روش تفکیک نواحی در آزمون فراصوتی اتوماتیک

تکنیک‌های قدیمی آزمون فراصوتی دستی نیازمند زیگزآگ پروب در اطراف خط جوش (Raster Scan) بودند.



## روش تفکیک نواحی در آزمون فراصوتی اتوماتیک (ادامه)

ارتفاع جوش را به نواحی عمودی تقسیم می‌کنند که هر کدام از آنها توسط یک جفت پروب فراصوتی از دو طرف خط مرکزی جوش ارزیابی می‌شوند.

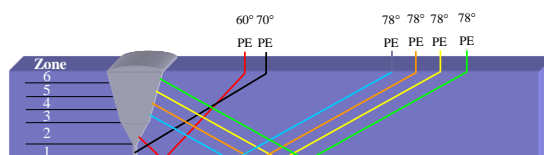
| Zone | Zone Identification        |
|------|----------------------------|
| 6    | 2 <sup>nd</sup> Fill & Cap |
| 5    | 1 <sup>st</sup> Fill       |
| 4    | Hot Pass (Upper)           |
| 3    | Hot Pass (Lower)           |
| 2    |                            |
| 1    | Root                       |

## منطقه بندی پخ جوش

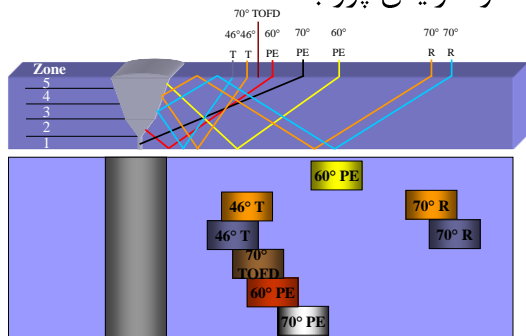
حالت اول

| Region      | Zone Identification | Thickness |
|-------------|---------------------|-----------|
| Cap Region  | Cap                 | 2.5 mm    |
|             | Fill3               | 2.1 mm    |
|             | Fill2               | 2.1 mm    |
| Body Region | Fill1               | 2.1 mm    |
|             | Hot Pass            | 2.7 mm    |
| Root Region | Root                | 1.5 mm    |

## نحوه آرایش پروبها در حالت ایده‌آل



## نحوه آرایش پروبها

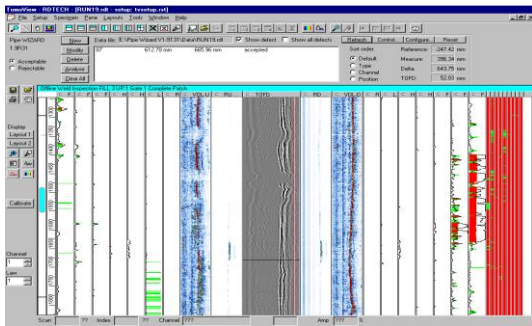


## AUT system in operation

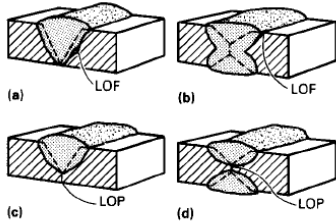


Acknowledgments to Olympus NDT

# Strip Chart

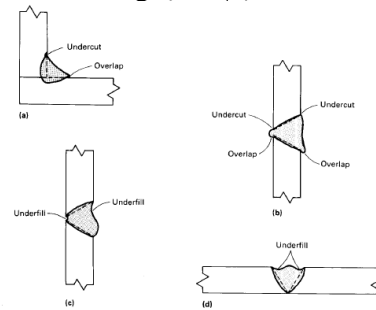


## عيوب جوش



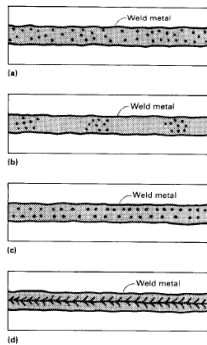
**Fig. 4** Lack of fusion in (a) a single-V-groove weld and (b) double-V-groove weld. Lack of penetration in (c) a single-V-groove and (d) a double-V-groove weld

## عيوب جوش



**Fig. 5** Weld discontinuities affecting weld shape and contour. (a) Undercut and overlapping in a fillet weld. (b) Undercut and overlapping in a groove weld. (c) and (d) Underfill in groove welds

## تخلخل



## عيوب جوش

