

2011 LOCK MAINTENANCE WORKSHOP

Pittsburgh, PA

17 February 2011

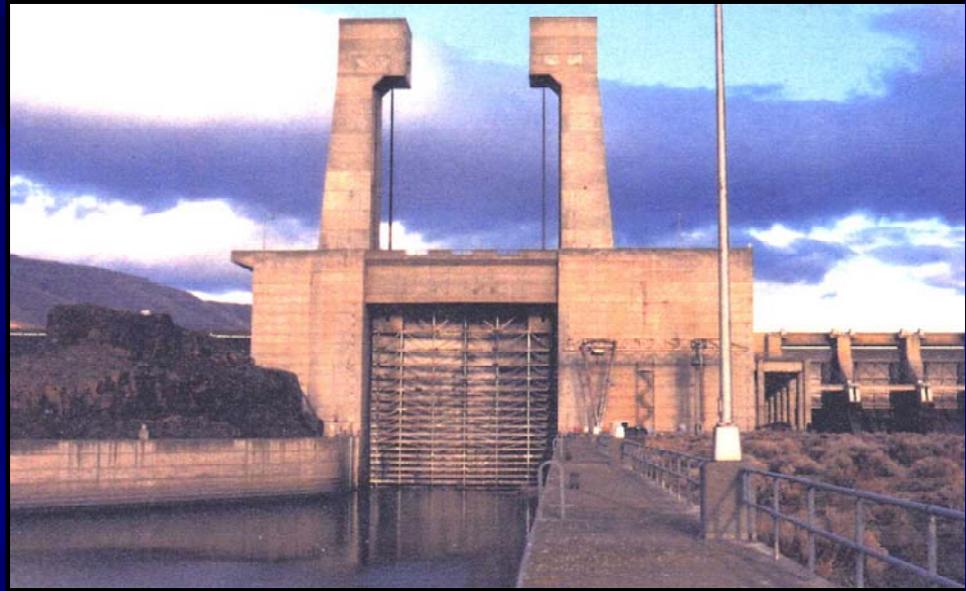
Hydraulic Steel Structures

(HSS) Overview

Phil Sauser

USACE-Saint Paul District

HSS



INTRODUCTION

I. ER 1110-2-8157

II. Perspectives

III. Practical Applications/Guidelines

ER 1110-2-8157

Responsibility for Hydraulic Steel Structures (HSS)

- *Engineering and Design*
- *CECW-CE/ CECW-CO*
- *Responsibilities*
 - *District's Chief of Engineering*

ER 1110-2-8157 - Highlights

- *Engineer*
 - *Qualified*
- *Certification*
 - *New and Existing*
- *Inspection Requirements*
 - *Types and Frequencies*
- *Repairs*
 - *Engineer designed*



Perspectives



Perspectives



© Scratch Macavill

Perspectives



Perspectives - Engineering



Perspectives - Engineering





Perspectives - Engineering





Perspectives - Operations

?

Perspectives - Operations

1/5/2001





Perspectives - Inspections

1. Why

- See Previous
- Exposure-Behavior

2. When

- Routine
- Special

3. How

- Access



Perspectives - Repairs

- **Engineering Support**
- **When It Matters**



Perspectives - Cooperation

- **Coordination**
- **Success**

Practical Applications

- 1. Concepts/Fundamentals**
- 2. Welding**
- 3. Bolting**
- 4. Repairs**

Practical Applications

1. Concepts/Fundamentals

- *Fracture*
- *Fracture Critical Members*
- *Fatigue*

Concepts - FRACTURE



Concepts - FRACTURE



DUCTILE

GOOD



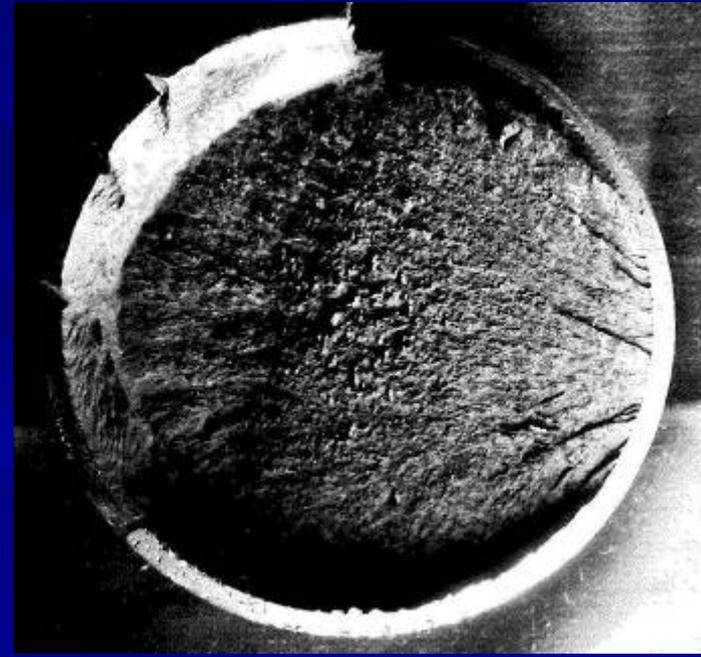
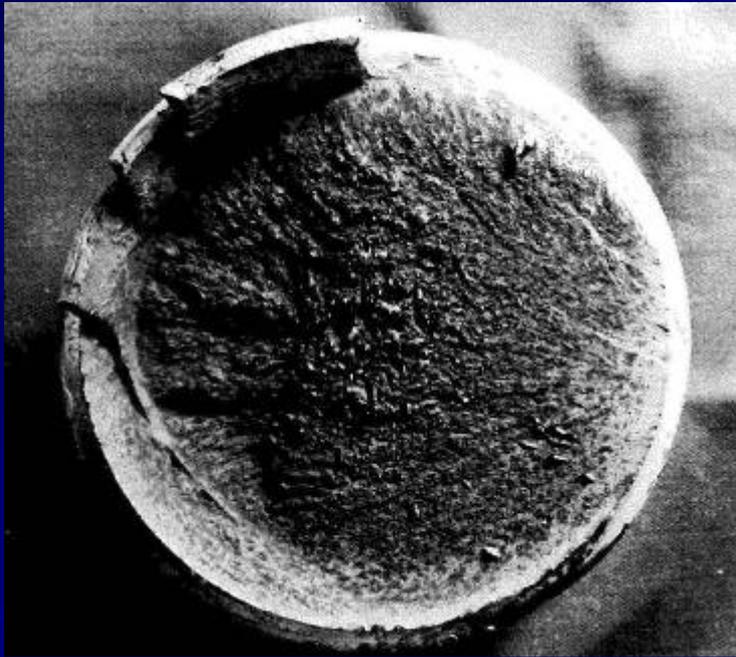
BRITTLE

BAD

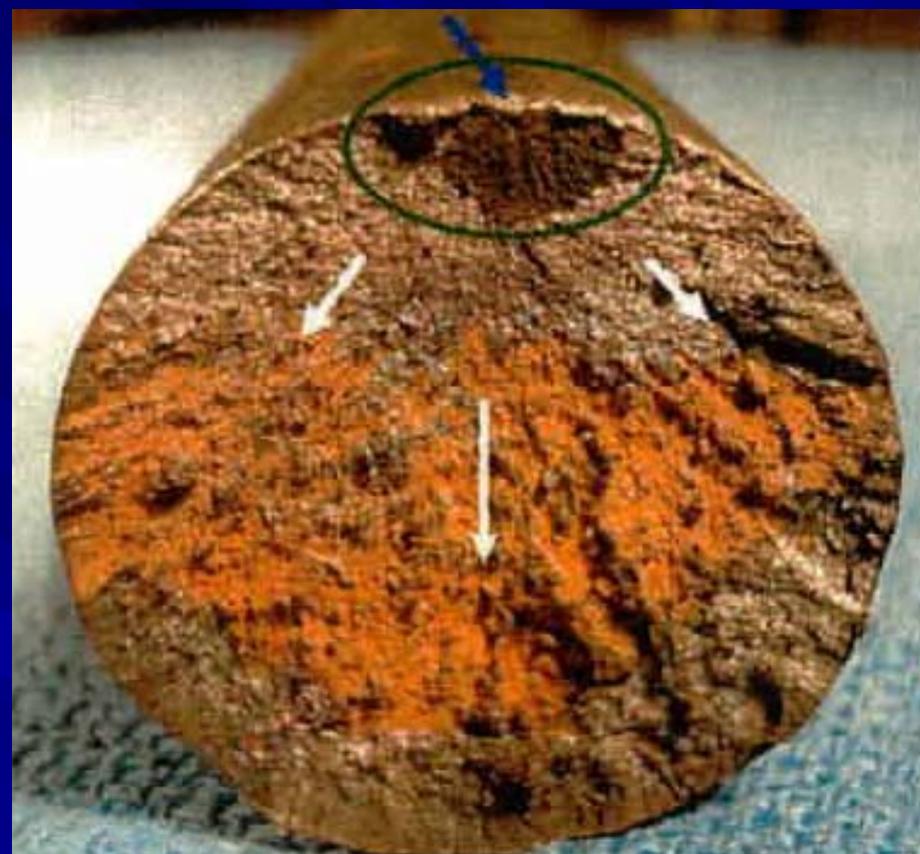
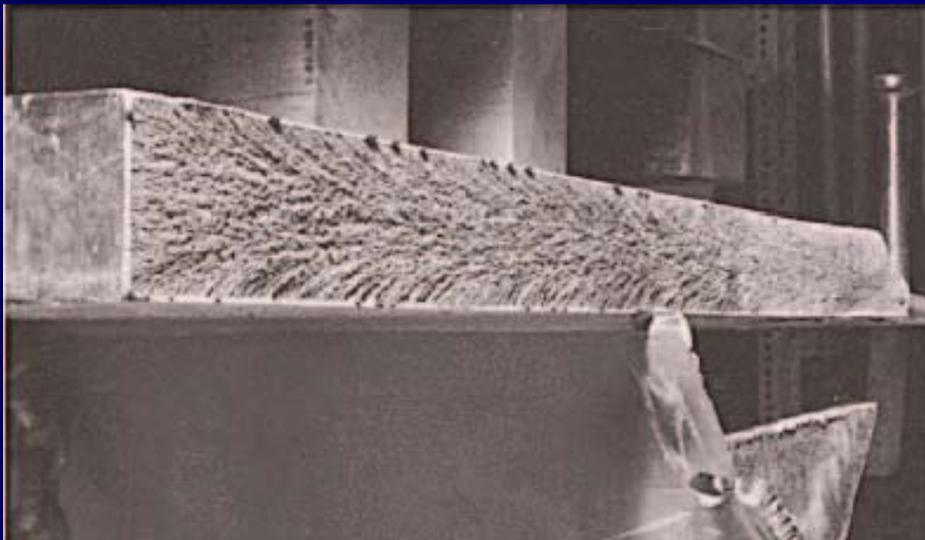
BRITTLE FRACTURE



BRITTLE FRACTURE



BRITTLE FRACTURE



Concepts - FRACTURE

More

INFLUENCES

LESS

Lower

Temperature

Higher

Higher

Impact

Lower

Lower

Toughness

Higher

Higher

Stress

Lower

Larger

Flaws

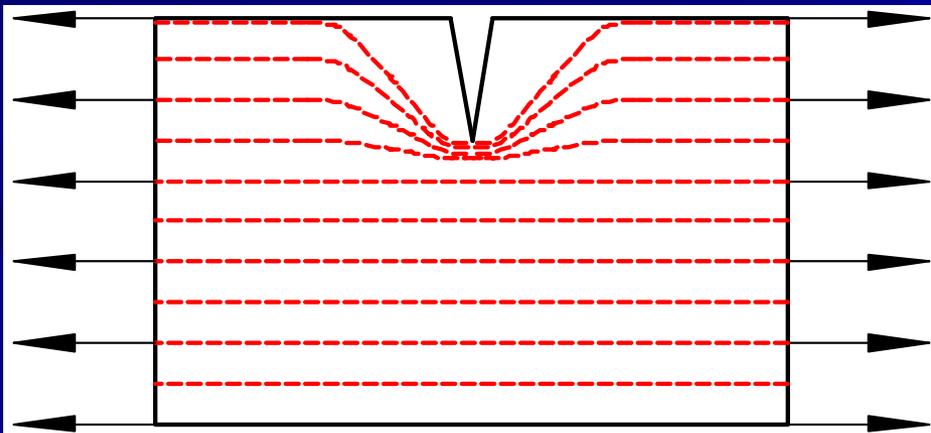
Smaller

Fracture Influences - FLAWS

Stress Flow/Stress Concentration



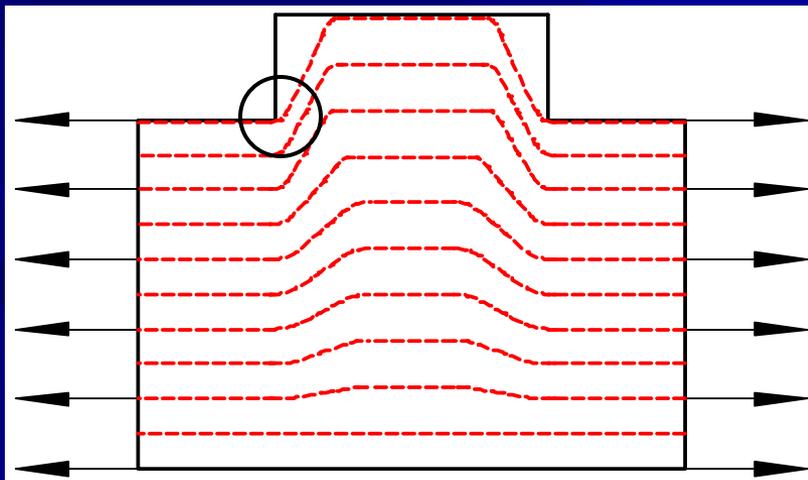
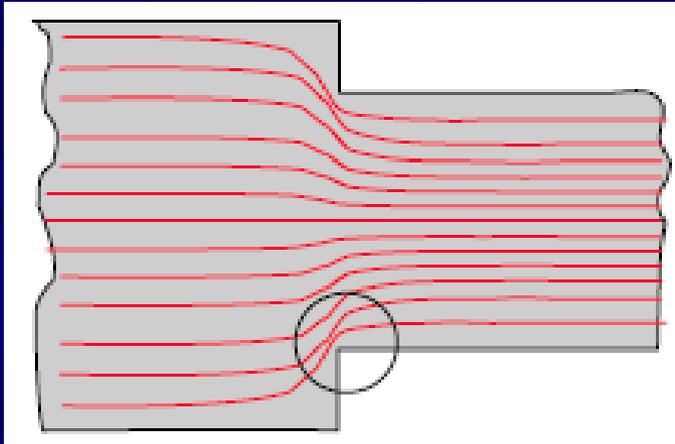
Uniform



Notch

Fracture Influences

Stress Concentration



*Change in
Dimension/
Geometry*

Fracture Influences

Constraint/Restraint



Fracture Influences

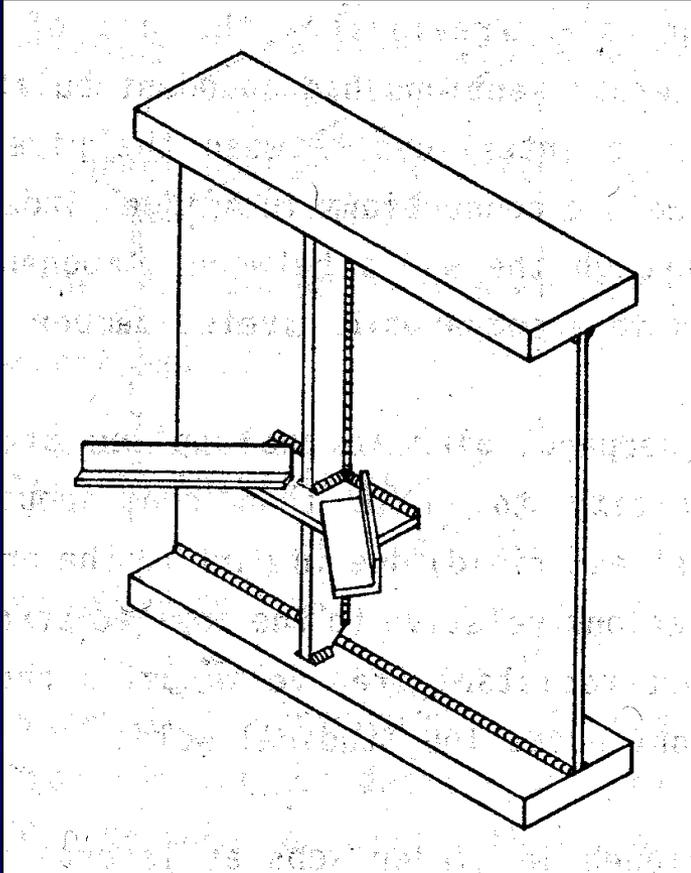
Constraint



Intersecting Welds

Fracture Influences

Constraint



**Intersecting
Members**



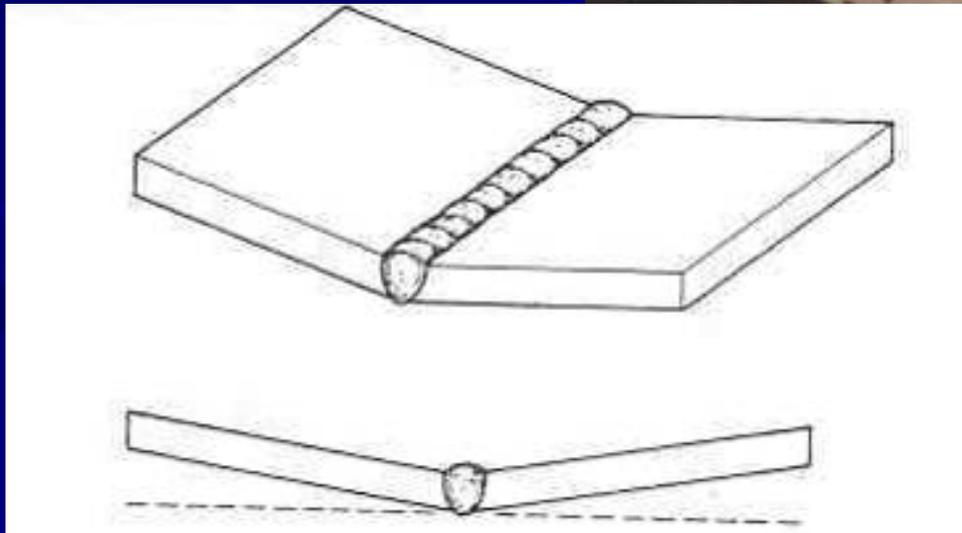
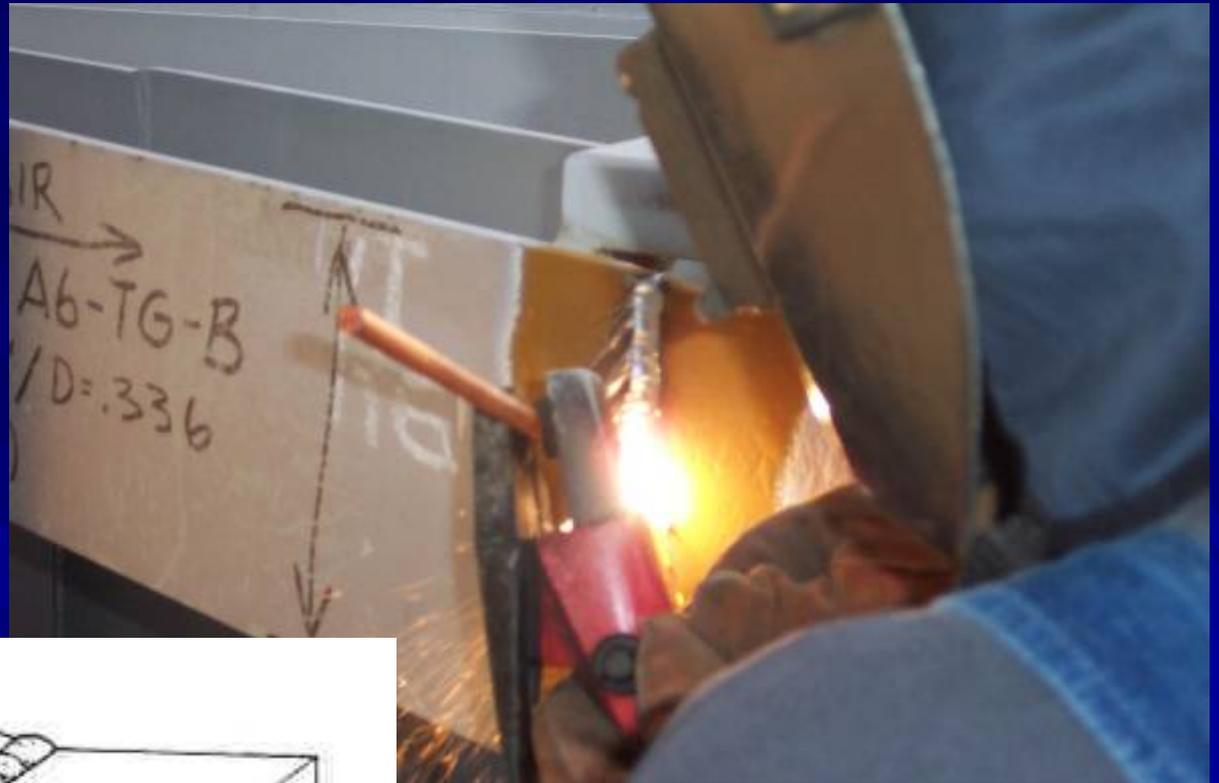
**Thick Members
Large Welds**

Constraint



Fracture

Residual Stress



Fracture

Fracture Critical Members (FCM)

1. *Steel*
2. *Tension*
3. *Collapse/Failure*
 - *Redundancy*

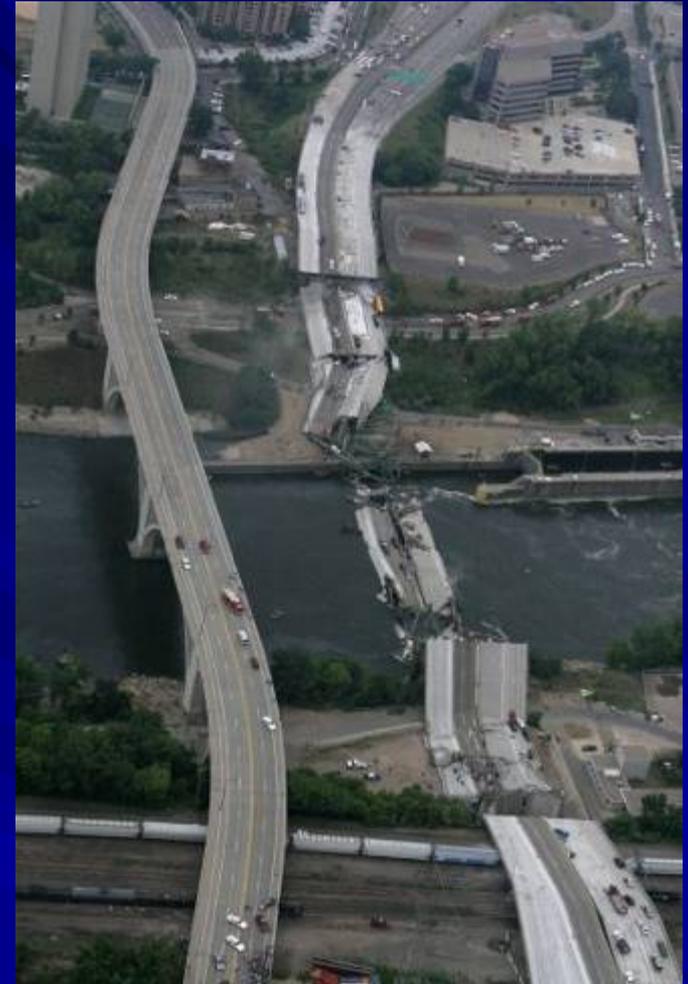
FCM



Failure



FCM



Redundancy

FCM



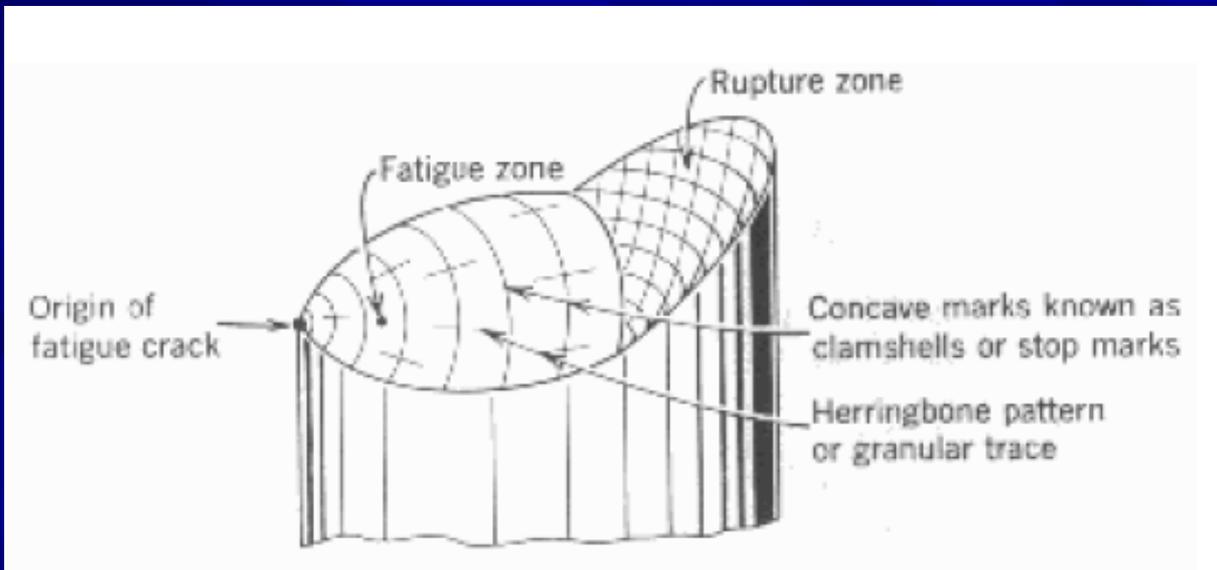
Redundancy

Concepts - FATIGUE

- *Repeated Loading*
 - *Lock Gates*
- *Cracks/Fractures*
- *Stress vs. Stress Cycles*

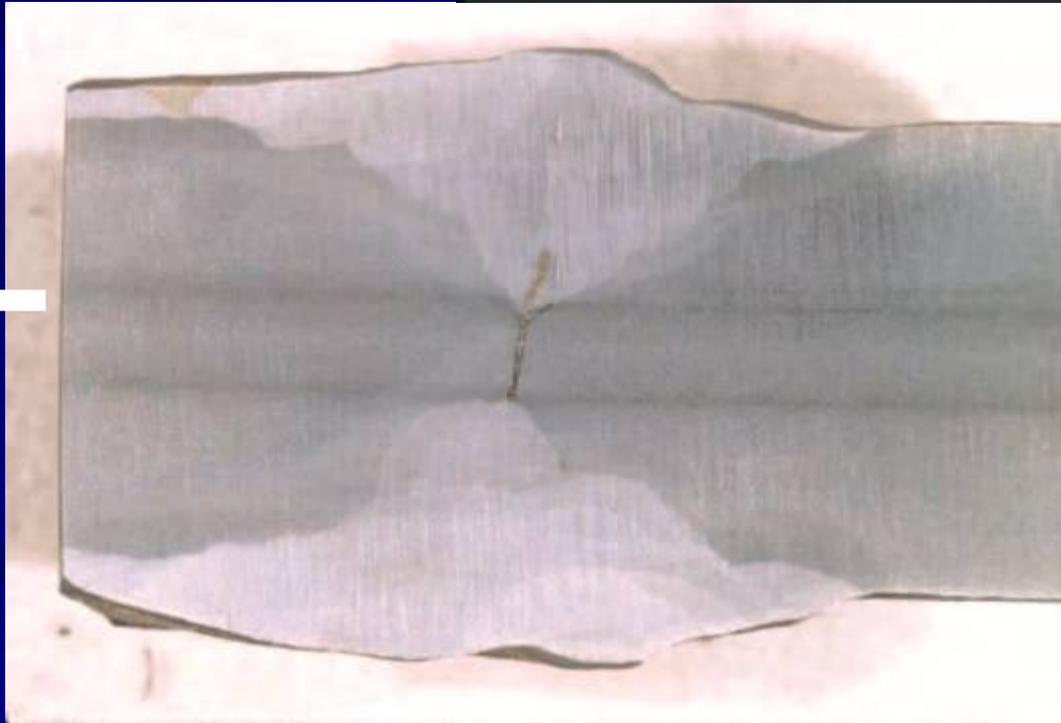
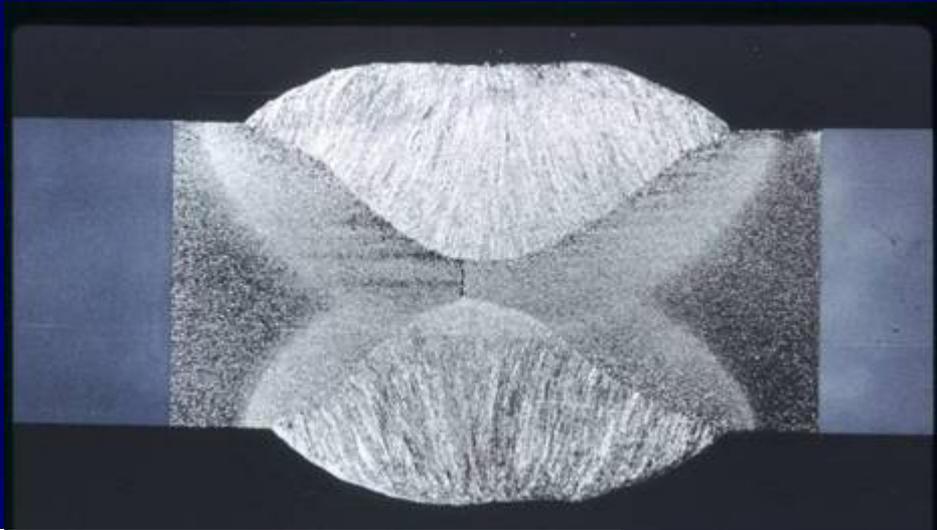
FATIGUE

- ***Three Stages = Fatigue Life***
 - ***Initiation***
 - ***Propagation***
 - ***Fracture***



FATIGUE

Initiation



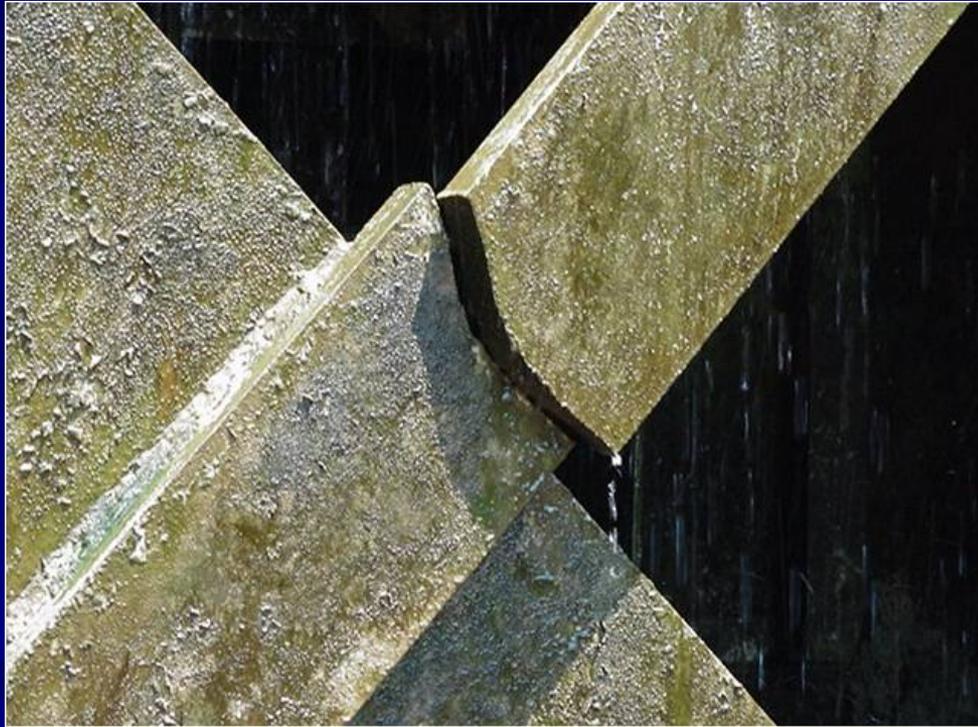
FATIGUE

Propagation



FATIGUE

Fracture



Practical Applications

2. Welding

- **Weld Procedures**
- **Weld Metal**
- **Joint Details**
- **Heat Input/Control**
- **Welding Quality**

Weld Procedure Specification (WPS)

Weld Recipe

- Joint Type
- Welding Process
- Weld Metal/Flux
- Amps/Volts
- Current Type
- Preheat/Interpass
- Welding Position
- Joint Detail

Weld Procedures

AWS D1.1/D1.1M:2004
An American National Standard



Structural Welding Code— Steel

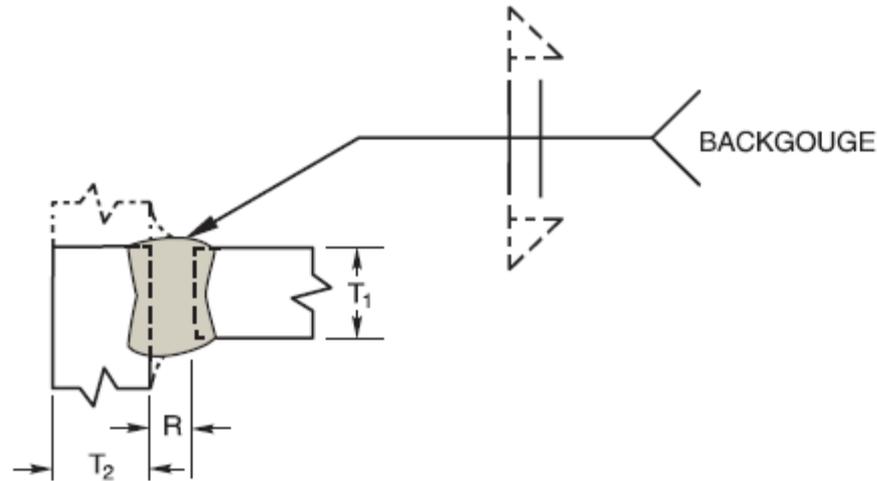


American Welding Society



Weld Procedures

Square-groove weld (1)
T-joint (T)
Corner joint (C)



| Welding Process | Joint Designation | Base Metal Thickness (U = unlimited) | | Groove Preparation | | | Allowed Welding Positions | Gas Shielding for FCAW | Notes |
|-----------------|-------------------|---|-------|---------------------|-----------------------------|---------------------------|---------------------------|------------------------|---------|
| | | | | Root Opening | Tolerances | | | | |
| | | T_1 | T_2 | | As Detailed (see 3.13.1) | As Fit-Up (see 3.13.1) | | | |
| SMAW | TC-L1b | 1/4 max | U | $R = \frac{T_1}{2}$ | +1/16, -0 | +1/16, -1/8 | All | — | 4, 5, 7 |
| GMAW FCAW | TC-L1-GF | 3/8 max | U | $R = 0$ to 1/8 | +1/16, -0 | +1/16, -1/8 | All | Not required | 1, 4, 7 |
| SAW | TC-L1-S | 3/8 max | U | $R = 0$ | ± 0 | +1/16, -0 | F | — | 4, 7 |

Weld Metal

1. *Hydrogen Control*

- *Filler Metal Type*
- *Moisture Control*



Joint Details

Copes

- *Weld Access*
- *Avoid Intersecting Welds*



Joint Details

Terminations

➤ *Filletts*



Wrap



Hold Back

Joint Details

Terminations

- **CJP**
 - ☐ **Weld Tabs**



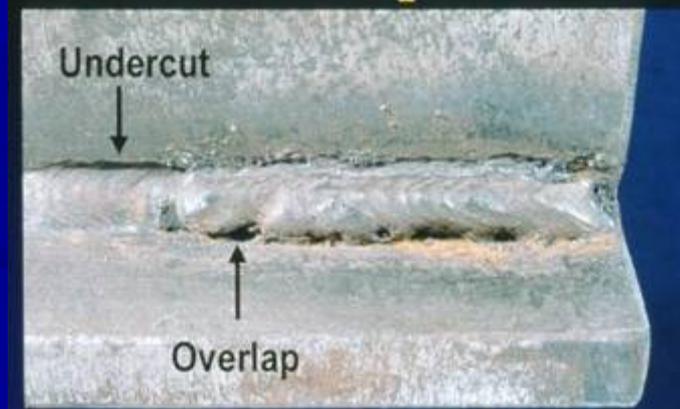
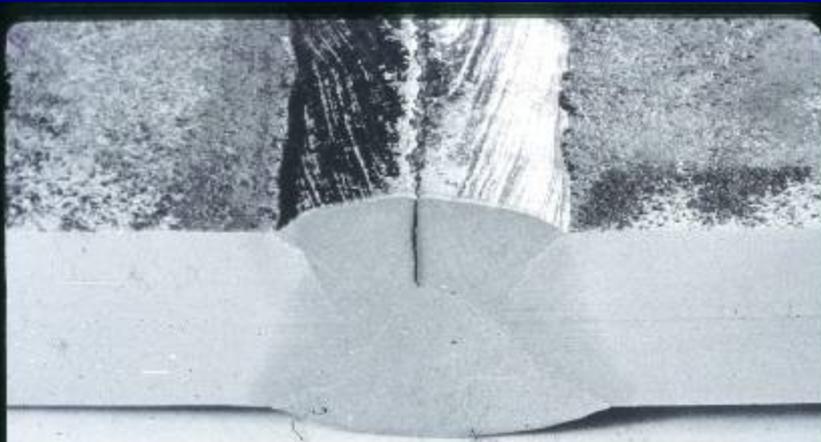
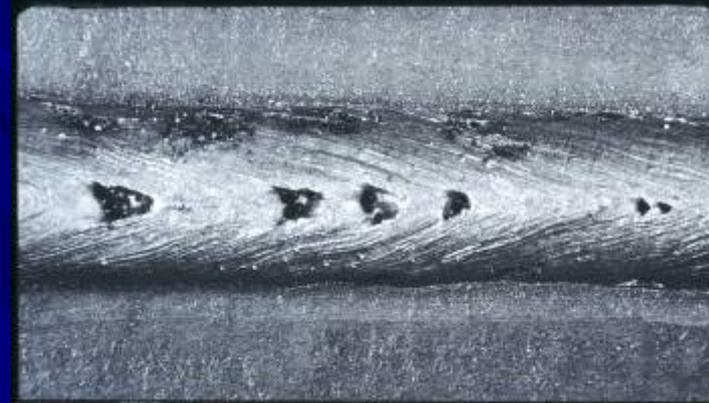
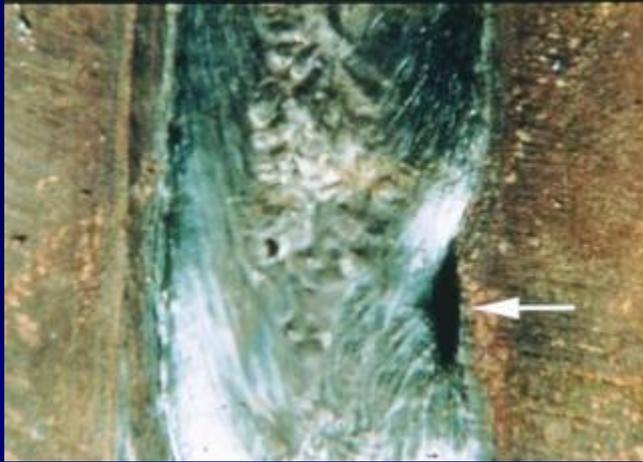
Heat Input/Control

1. *Residual Stress*
2. *Cooling Rates*

- *Preheat*
- *Weld Size*
- *Sequence*



Welding Quality NDT



Practical Applications

2. Bolting

- **Installation Types**
- **Installation Methods**
- **Quality Control**

Bolting

Bolt Installation Types

- **Bearing Bolts**
- **Fully Pretensioned**
- **Slip Critical**
- **High Strength Bolts – A325 (A490)**

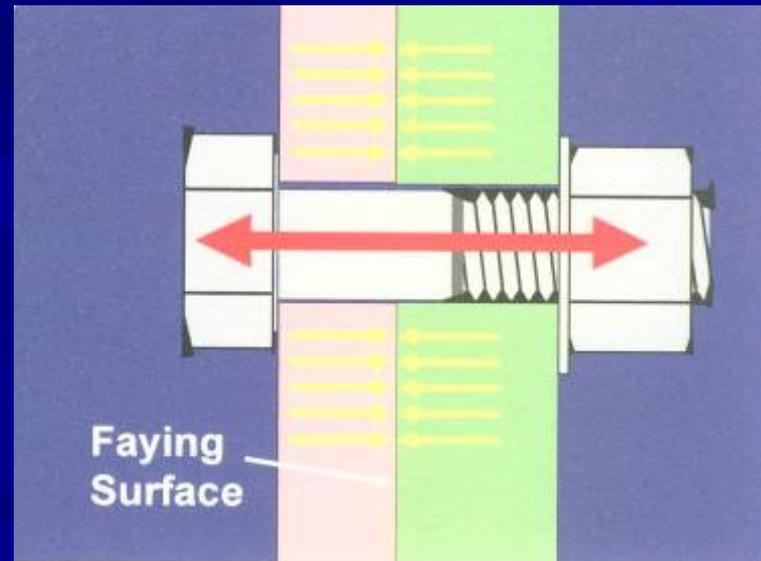


Bolting

Bearing Bolts

Fully Pretensioned

Slip Critical



Bolting

Installation Methods

- **Turn of the Nut**
- **Direct Tension Indicator (DTI)**
- **Twist-Off**
- **Calibrated Wrench**

Bolting

Installation Methods

- Turn of the Nut
- Direct Tension Indicator (DTI)
- Twist-Off
- ~~Calibrated Wrench~~

Bolting Installation

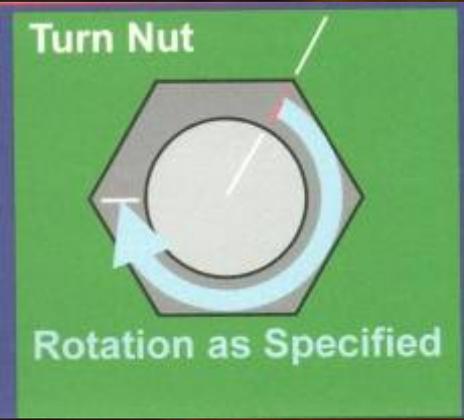
Snug Tight

- *Full effort of a worker with an ordinary spud wrench*
- *A few hits of an impact wrench*

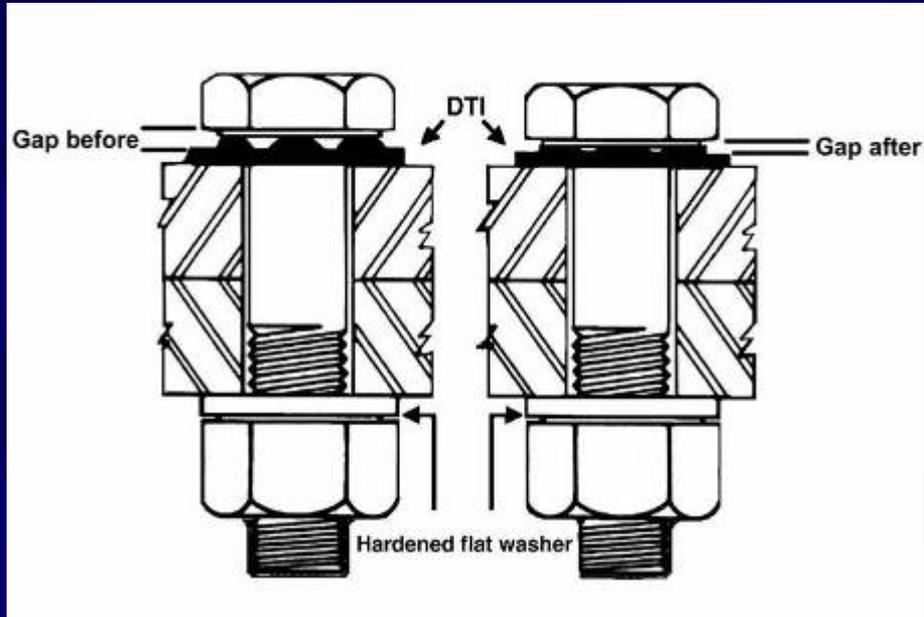
Bolting Installation

Turn of the Nut

- **Mark Nut, Bolt, Plate**
- **Turn Nut (Table Values)**
- **Sequence**
- **10 Second Rule**



Bolting Installation



DTI

Twist-Off

Bolting

- **Lubrication**
- **Storage**
- **Calibration**

Bolting

➤ Lubrication

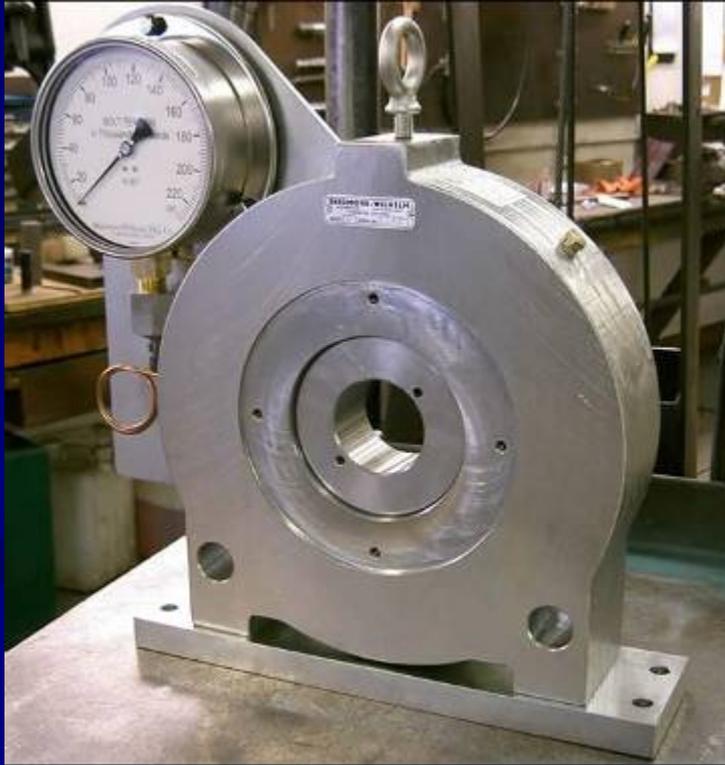
Bolting

➤ Storage



Bolting

- **Calibration**
 - ❑ **Rotational Capacity Test**



Practical Applications

3. Repairs

- **Grinding**
- **Drilling**
- **Weld Repairs**
- **Documentation**

Repairs

Grinding

➤ Tools



Repairs

Grinding

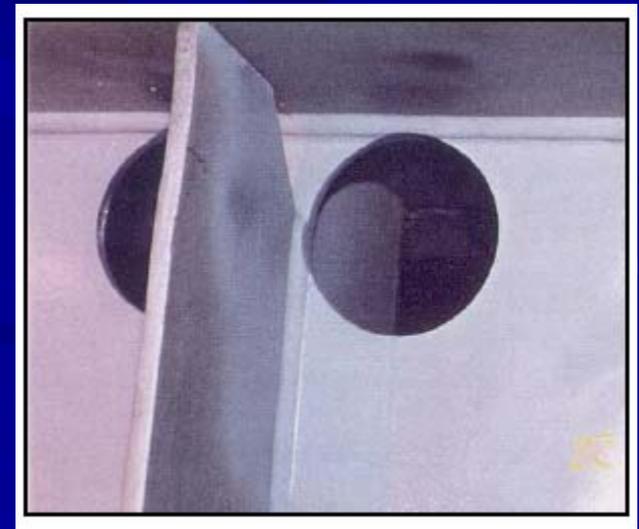
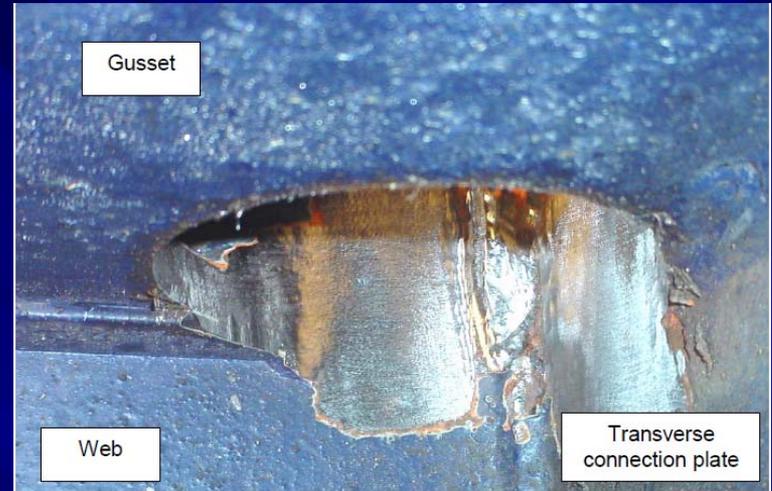
- **Grinding Direction**
- **Transitions (1:10)**
- **Coarse to Fine**



Crack Repairs

Drilling

- Crack Repair
- Remove Intersecting Welds



Weld Repairs

Crack Repairs

➤ Temporary Repairs



Weld Repairs

Copes

- Weld Access
- Avoid Intersecting Welds



Weld Repairs

Transitions

- **Smooth/Gradual**
 - **6" Radius**
 - **1:2.5 Slope**



DOCUMENTATION

- Weld Procedures**
- Material Reports**
- Test Reports**

