SHOP AWARENESS BRIEFING

WHY AN AWARENES «IEFING?

- TO EXPLAIN PROBLEMS (WHAT AND WHY) THAT OCCUR WHEN PARTS ARE IMPROPERLY TRIMMED, SHIMMED, CLAMPED, ETC.

- PROVIDE SHOP PERSONNEL BACKGROUND FOR TRIM REWORK THAT AFFECTS AIRCRAFT STRENGTH AND DURABILITY (LIFE)

GROUND RULES

* PRESENTATION HAS 5 SECTIONS
  * INTRODUCTION
  * GAPS & SHIMMING
  * TRIMMING
  * FASTENERS
  * TRIM EMPOWERMENT

* HOLD QUESTIONS UNTIL THE END OF EACH SECTION (IF TIME DOES NOT PERMIT YOUR QUESTION TO BE ANSWERED,CONTACT PERSONS LISTED IN HANDOUT OR YOUR LIAISON ENGINEER)

* 5 MIN BREAK HALFWAY THROUGH BRIEFING

* MANUFACTURING PERSONNEL WILL BE ALLOWED TO TAKE NORMAL 10 MIN BREAK AFTER THE BRIEFING

GROUND RULES

* THIS BRIEFING DOES NOT GIVE ANY AUTHORITY TO PERFORM REWORK.

* THE ENGINEERING DRAWINGS, SPECIFICATIONS & ENGINEERING DISPOSITIONS ARE STILL THE AUTHORIZING DOCUMENTS.

WHY AN AWARENESS BRIEFING?

* VISITS TO CUSTOMER BASES AND FIELD SERVICE REPORTS INDICATE STRUCTURAL FAILURES OCCUR FREQUENTLY.

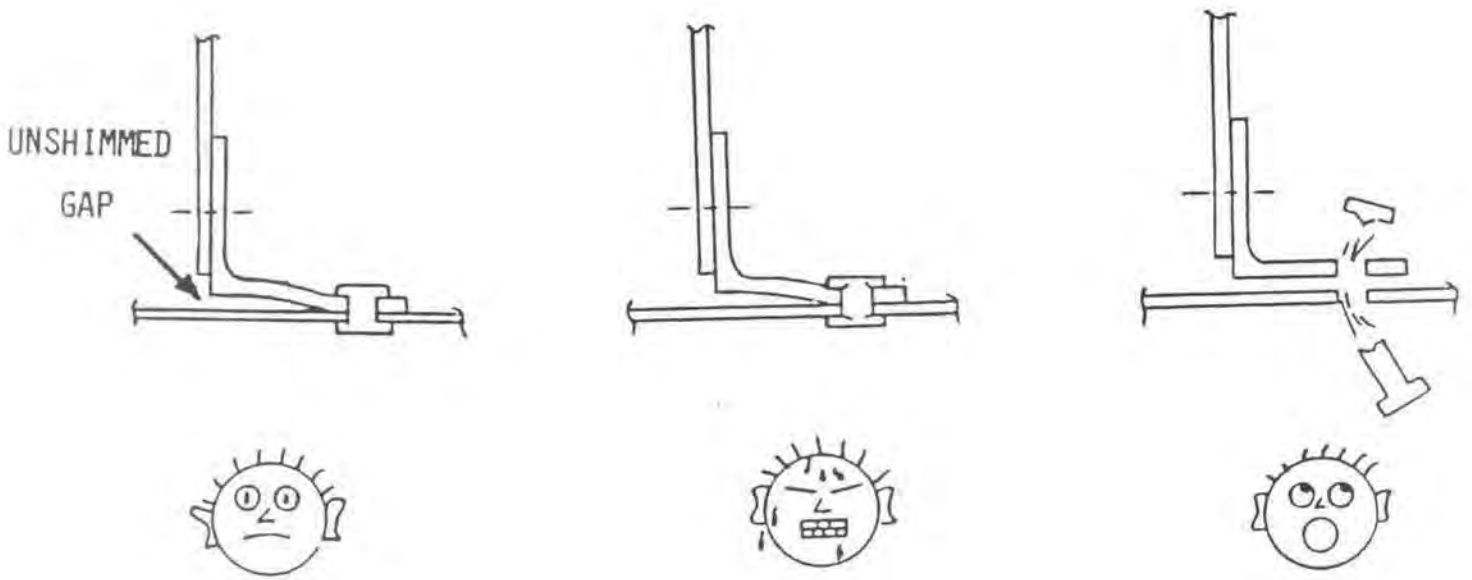
* THESE FAILURES REQUIRE REWORK AND GROUND TIME TO RETURN THE AIRCRAFT TO FLIGHT STATUS.

* THESE FAILURES CAN BE PRIMARILY ATTRIBUTED TO PROBLEMS ENGINEERED AND MANUFACTURED INTO THE AIRPLANE.

WHY A BRIEFING?

TO PROVIDE YOU (MANUFACTURING) AN AWARENESS OF WHAT IS REQUIRED TO KEEP THE AIRPLANE PERFORMING AS ADVERTISED FOR YEARS TO COME.

MOST PROBLEMS TAKE TIME TO SHOW UP. IT MAY NOT BE APPARENT IN THE SHOP, BUT ONCE THE PLANE STARTS FLYING - WATCH OUT!



WHEN INSTALLED

WHEN THE PLANE FLIES

OOPS!

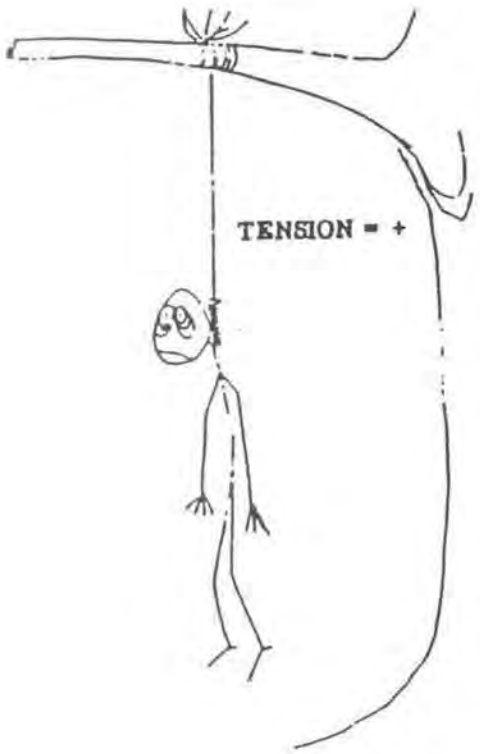
AWARENESS BRIEFING

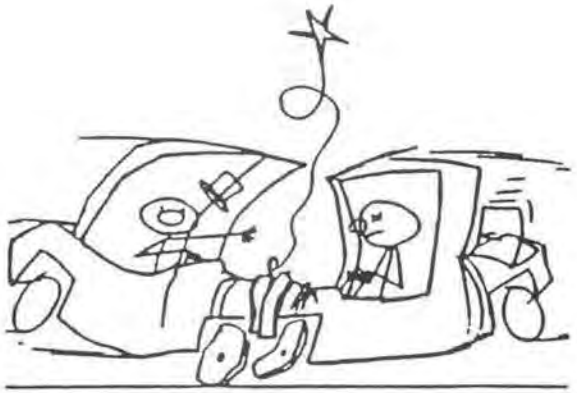
DEFINITIONS

SEVERAL TERMS WILL BE UTILIZED THROUGHOUT THESE BRIEFINGS AND NEED TO BE UNDERSTOOD.

- o LOAD (TENSION , COMPRESSION)
- o STRESS
- o FATIGUE
- o STRESS RISER

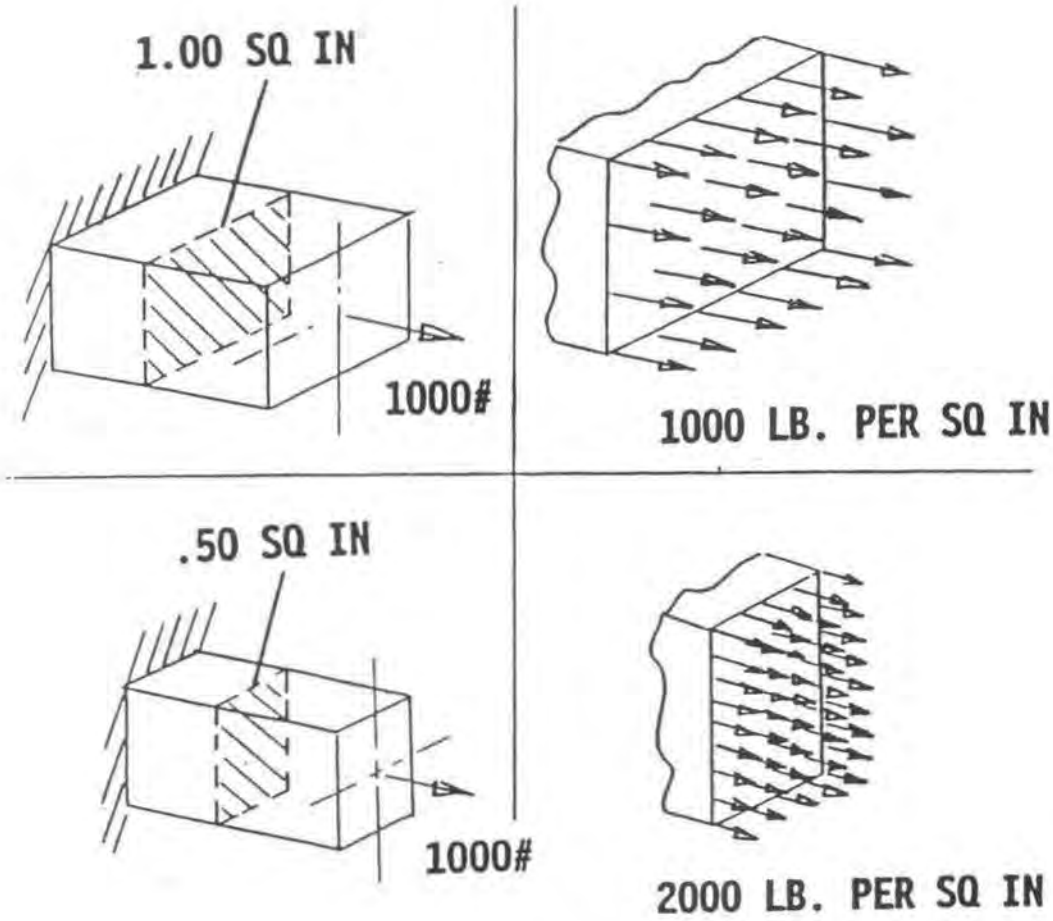
BASIC TYPES OF LOADING



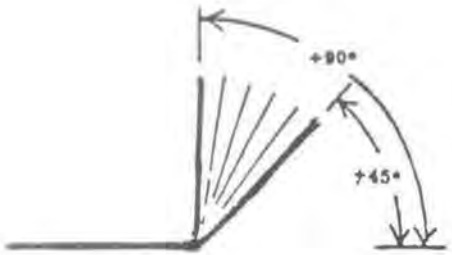


COMPRESSION = -

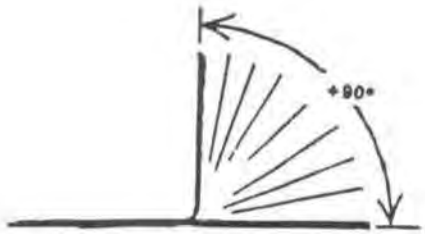
STRESS



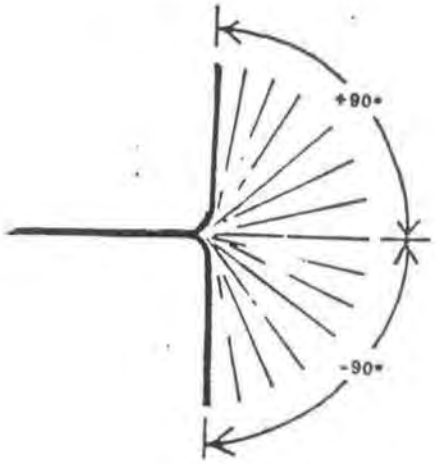
FATIGUE



70 CYCLES
45-to 90-DEGREE BENDING



15 CYCLES
0 to 90-DEGREE BENDING



5 CYCLES
90-DEGREE REVERSE BENDING

A galvanized 14-gage wire

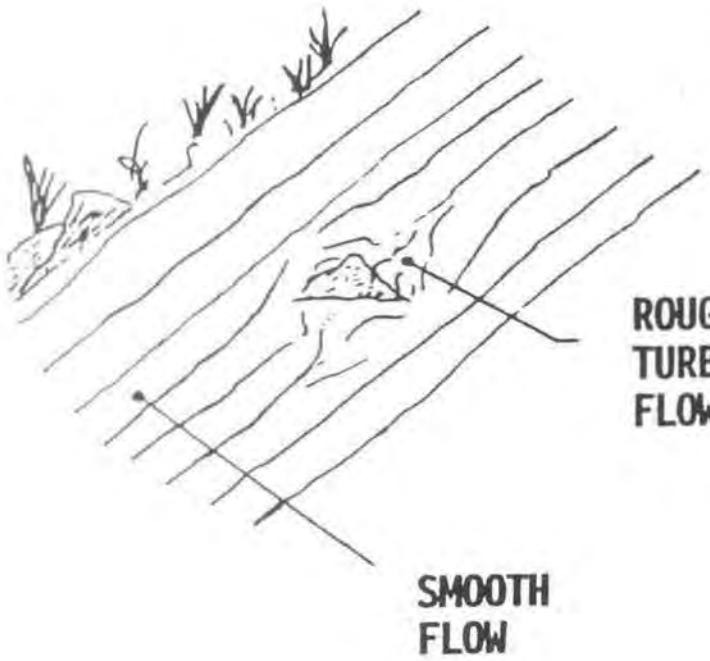
AWARENESS BRIEFING

STRESS RISERS

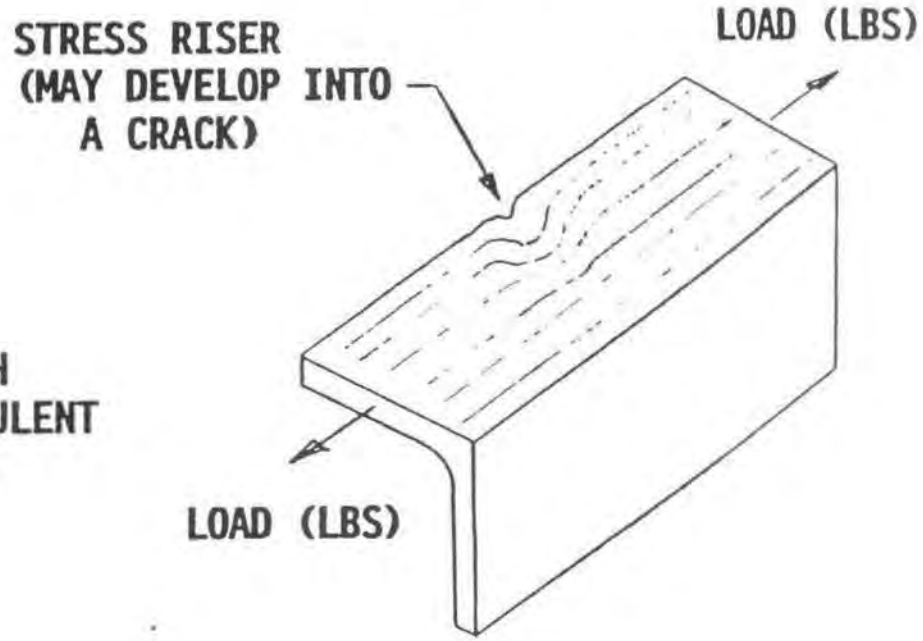
NICKS, GOUGES, UNDERCUTS, HOLES, SHARP EDGES, ETC.

SIMILAR TO AN OBSTRUCTION IN A STREAM

ROCK IN A STREAM



STRUCTURAL PART WITH AN UNDERCUT



GAPS

- CLAMPING
- SHIMMING

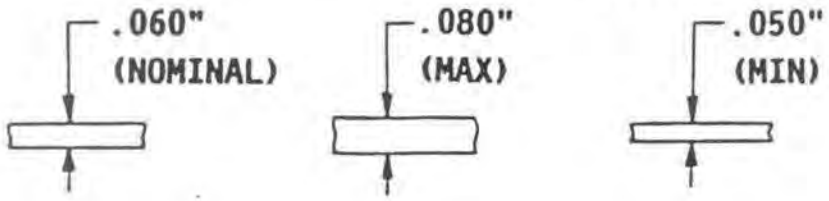
AN IDEAL AIRPLANE HAS NO GAPS

(ALL COMPONENTS ARE NOMINAL AND FIT TOGETHER AS INTENDED)

IN THE REAL WORLD:

TOLERANCE BUILD-UP ON STRUCTURAL PARTS, PARTS NOT MADE TO B/P, AND B/P ERRORS ALL LEAD TO GAPS.

TYPICAL DIMENSION = .060" $\pm \begin{matrix} .020 \\ .010 \end{matrix}$ INCHES



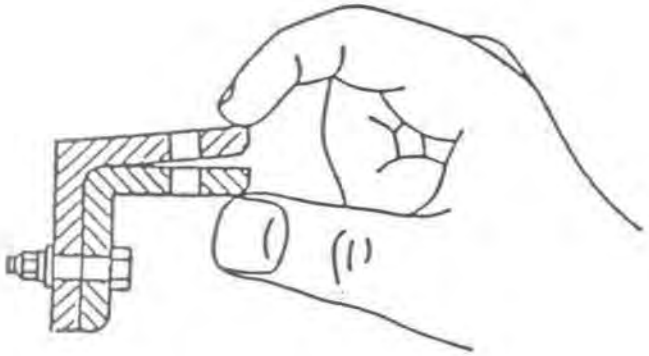
CLAMPING OUT A GAP

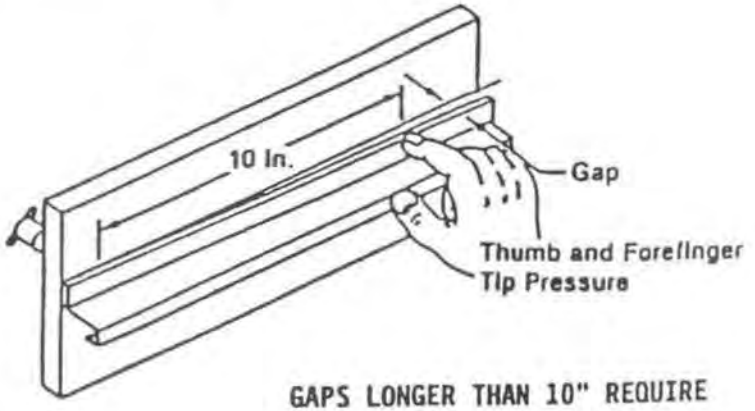
- THUMB/FOREFINGER RULE (REF. PROCESS SPEC. 19000)

  CAN A GAP (LOCALLY OR OVER 10" MAXIMUM) BE CLOSED USING ONLY THUMB AND FOREFINGER TIP PRESSURE?

IF YES - A SHIM IS PROBABLY NOT NECESSARY

IF NO - A SHIM OR REWORK IS REQUIRED





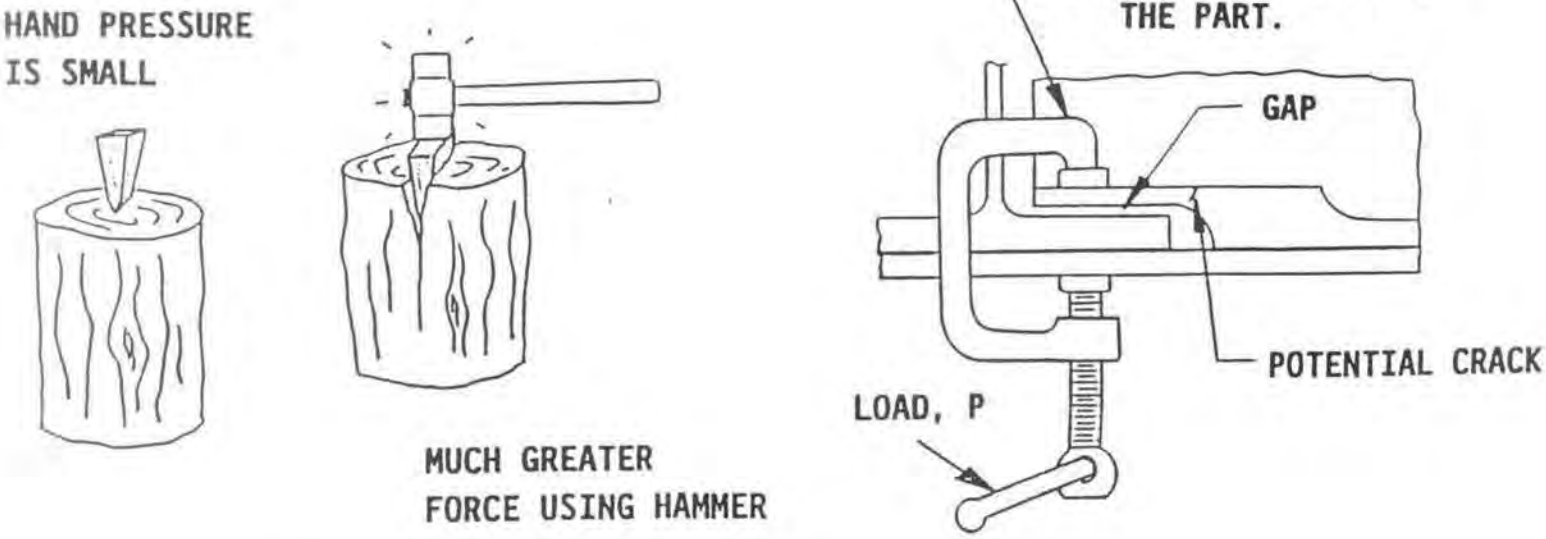
GAPS LONGER THAN 10" REQUIRE ENGINEERING CONSULTATION

AWARENESS BRIEFING

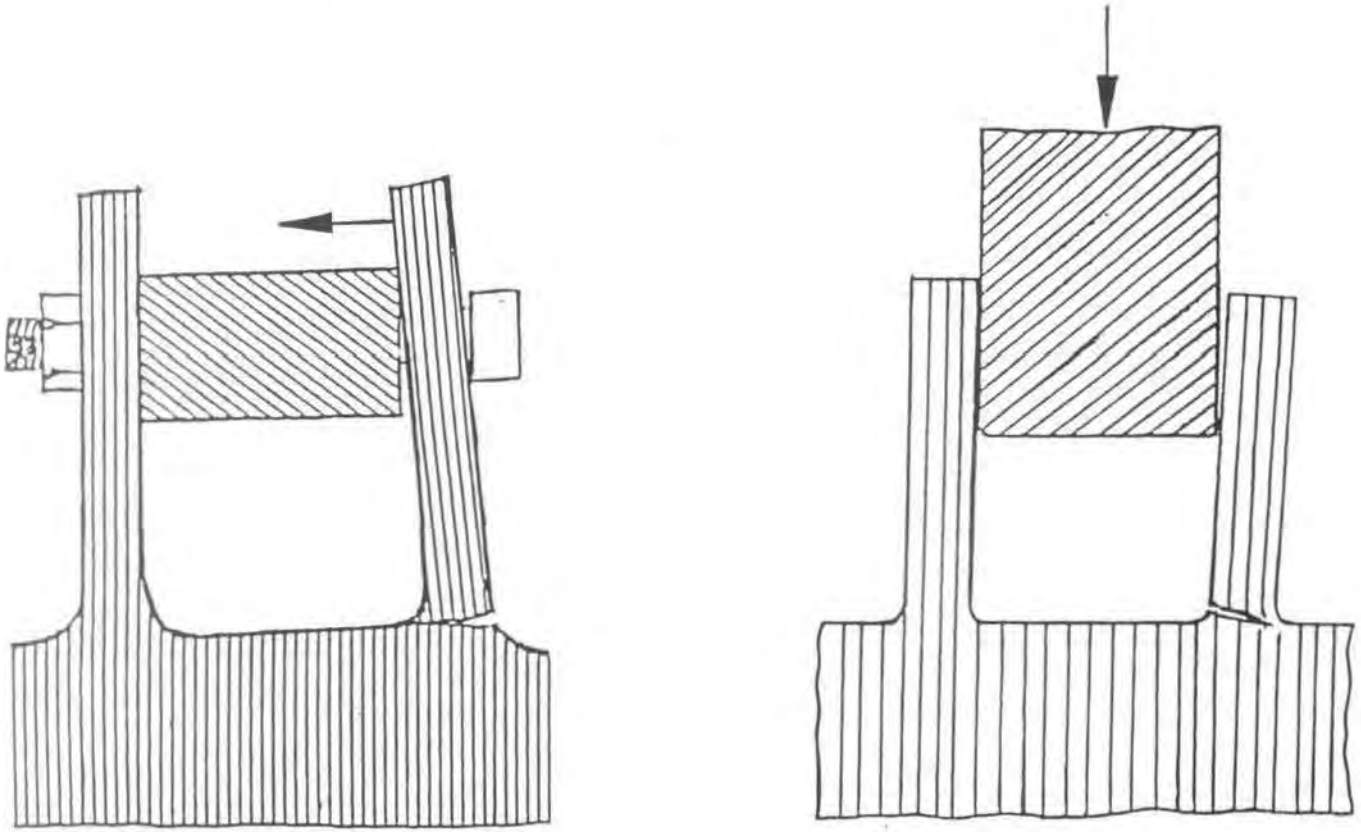
- FORCING PARTS INTO PLACE BY CLAMPING, HAMMERING, PRYING, ETC, IS UNDESIRABLE (CAUSES CRACKS).

- LOAD OR FORCE IS GREATLY INCREASED WHEN TOOLS ARE USED TO MAKE PARTS FIT.

  RESULT: DAMAGED PARTS OR FUTURE CRACKS DEVELOP IN THE AREA.



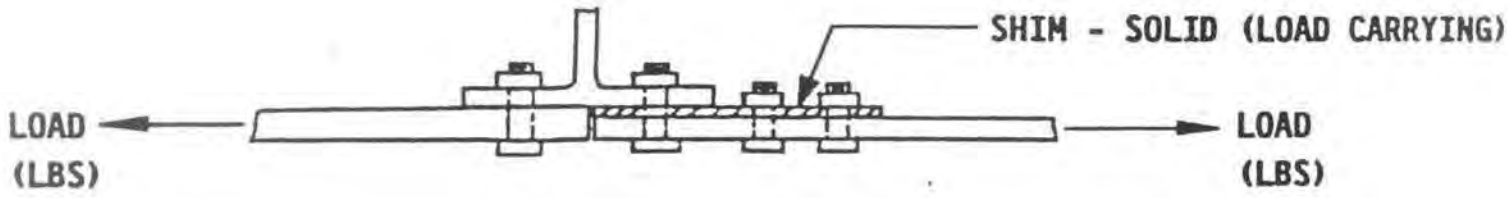
IF IT DOESN'T FIT, DON'T FORCE IT



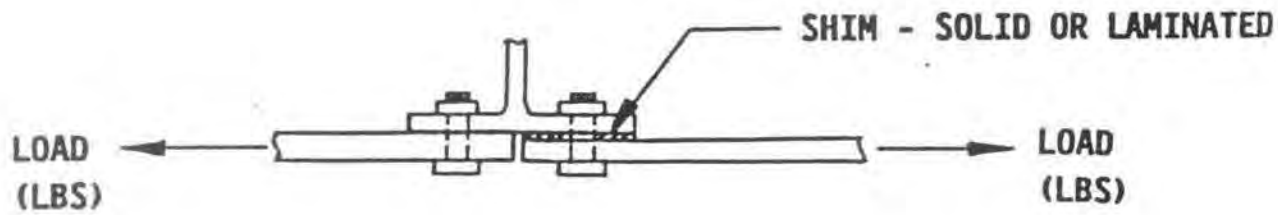
AWARENESS BRIEFING

PROPERLY DESIGNED SHIMS CAN MAKE ASSEMBLY OF PARTS EASIER.

A. STRUCTURAL SHIM (ATTEMPTS TO RESTORE B/P STRENGTH CAPABILITY AND IMPROVES FASTENER BENDING)



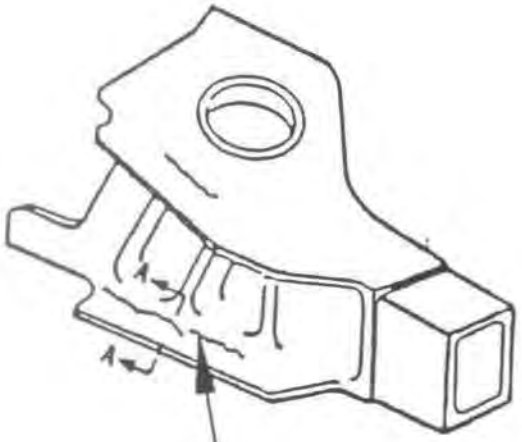
B. NON-STRUCTURAL SHIM; GAP FILLERS ONLY (1 FASTENER)

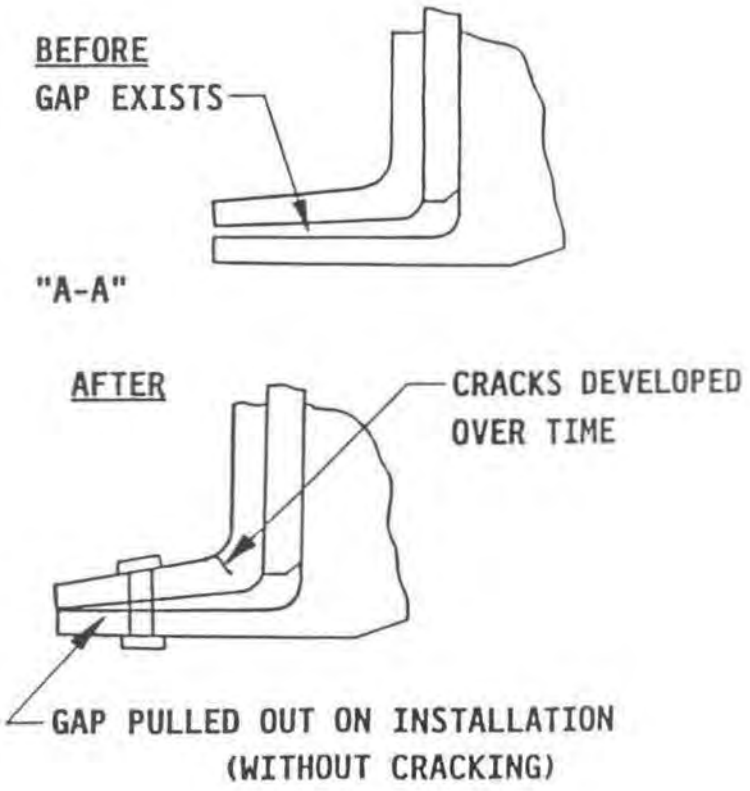


AWARENESS BRIEFING

- o HIGH LOADS/FORCES REMAIN IN A PART AFTER PULLING OUT A GAP
- o CRACKS MAY NOT OCCUR ON INSTALLATION, BUT CAN DEVELOP AND GROW OVER TIME.

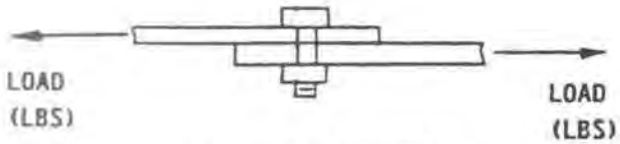
FLAP SCREW SUPPORT FITTING





DISADVANTAGES OF SHIMMED GAPS OR SPLICES

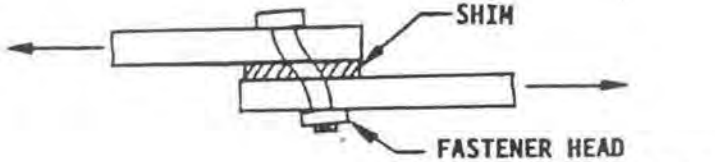
PREFERRED
UNSHIMMED SPLICE



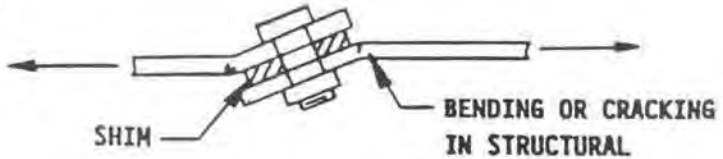
FASTENERS REMAIN
STRAIGHT AND TRUE

SHIMMED SPLICE

A.



B.



- THE GENERAL EFFECT OF A SHIM IS TO REDUCE THE STRENGTH OF A JOINT.
- THE CHANCE OF DEVELOPING PROBLEMS FROM SHIMS INCREASES AS SHIM THICKNESSES INCREASE.
- SHIM THICKNESSES GREATER THAN THOSE ALLOWED ON B/P'S MUST NOT BE INSTALLED WITHOUT LIAISON ENGINEERING DISPOSITION

AWARENESS BRIEFING

SHIMMING GUIDELINES (FOR REFERENCE ONLY)

A. ALWAYS CONSULT LIAISON ENGINEERING WHEN SHIMS ARE NOT CALLED OUT ON THE BLUEPRINT.

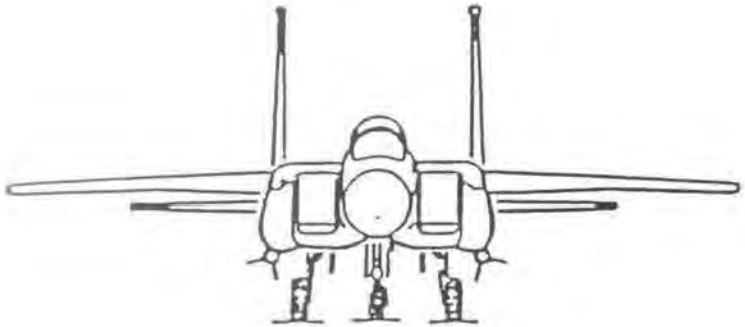
B. USE ONLY METAL SHIMS IN STRUCTURAL JOINTS.

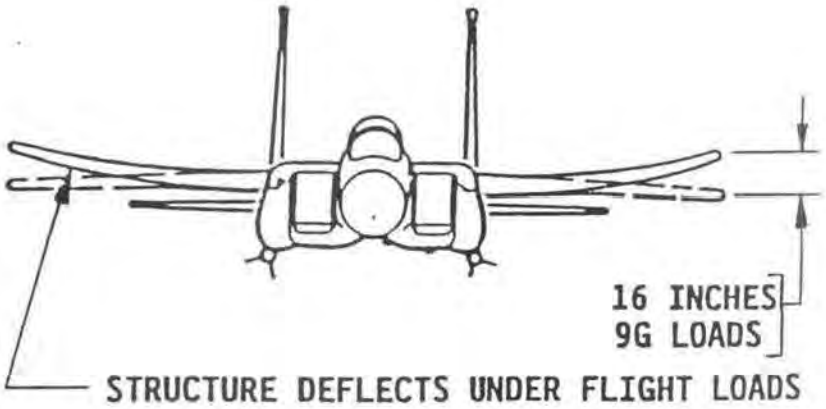
C. AVOID EXCESSIVE THICKNESS OF LAMINATED SHIMS. USE PART SOLID SHIMS WHEN THICKNESSES EXCEED .032".

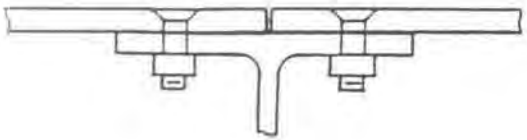
D. LIQUID SHIMS SHOULD ONLY BE USED IN LOW LOAD AREAS AND ARE ACCEPTABLE ONLY BY ENGINEERING DISPOSITION

MOLDLINE BUTT GAPS: BLUEPRINT GAPS SHOULD BE MAINTAINED

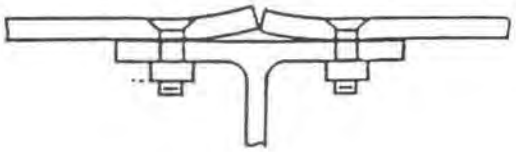
- STRUCTURAL FLEXING DUE TO FLIGHT LOADS
- HIGH TEMPERATURE EXPANSION
  (HIGH SPEED FLIGHT CAUSES HIGH SURFACE TEMPERATURES)
- PARTS RUBBING TOGETHER REMOVES PROTECTIVE COATINGS





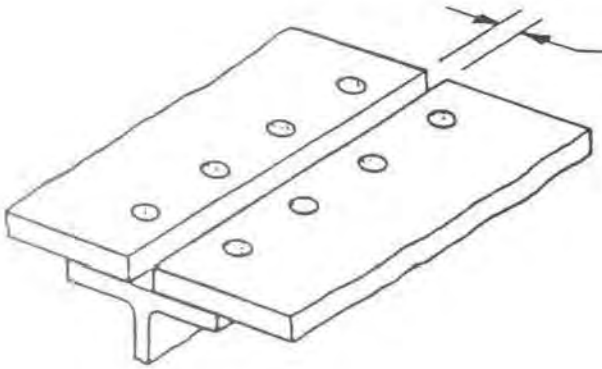


UNDEFLECTED CONDITION



SKINS BUCKLE AND RUB TOGETHER IF MOLDLINE GAPS ARE NOT MAINTAINED

MOLDLINE BUTT GAPS



MINIMUM .010" (UNLESS SPECIFIED OTHERWISE)
MAXIMUM .020" TO .120" DEPENDING ON TYPE OF STRUCTURE

REF. DWG 68A900001 FOR ALLOWABLE GAPS
(68A327000 FOR THE INLET AIR DUCT)

TRIMMING

AWARENESS BRIEFING

REASONS FOR TRIMMING

* POOR FIT WITH MATING PARTS

* NICKS, GOUGES, CRACKS, DRILL MARKS

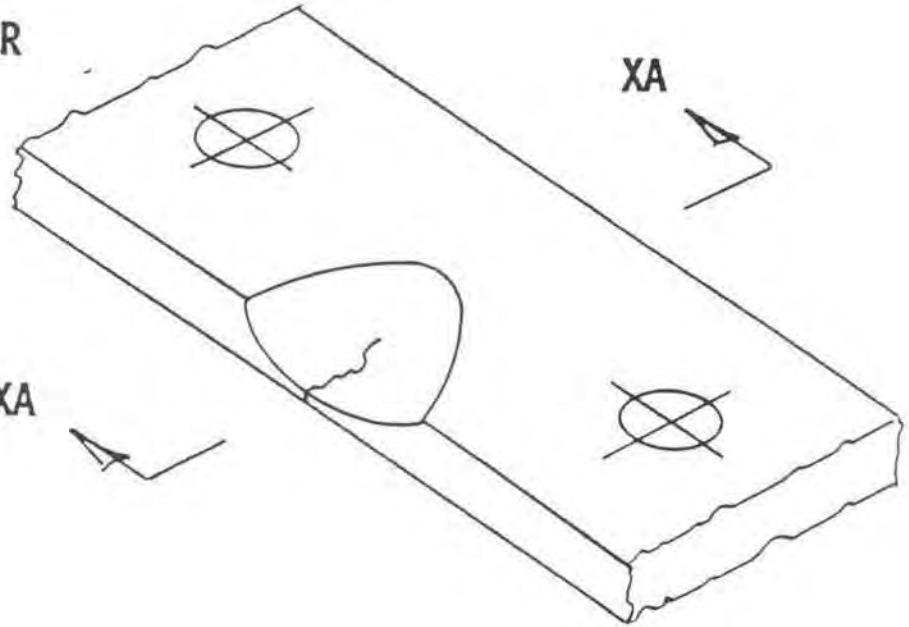
* HOLES FALLING IN OR NEAR STEPS, FLANGES OR ADJACENT PARTS

PRECAUTIONS WHEN TRIMMING

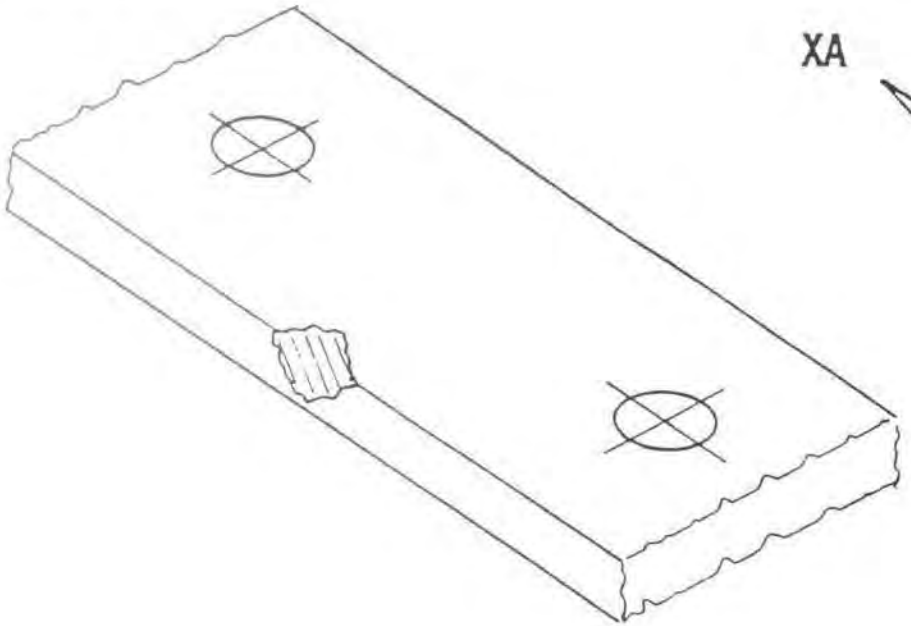
* REMOVING TOO MUCH THICKNESS
* REDUCTION OF FLANGE WIDTH - ESPECIALLY AREADY SHORT STIFFENING ("RETURN") FLANGES
* MACHINED STEPS (TRANSITIONS) TOO SHORT
* TRIM TOO CLOSE TO HOLES
* TOO SMALL CORNER/FILLET RADII
* POOR SURFACE FINISH
* MAKING SHARP EDGES
* TRIM PROFILE TOO SHARP - NOT GRADUAL

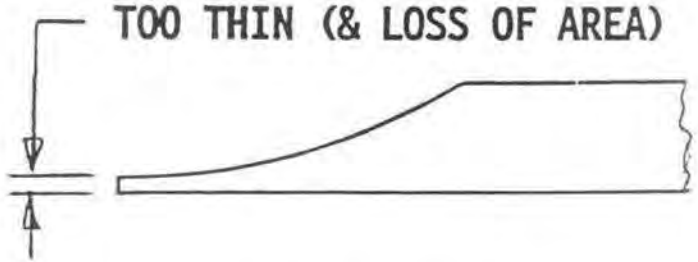
BLENDING MAY REMOV[illegible]OO MUCH THICKNESS

AFTER



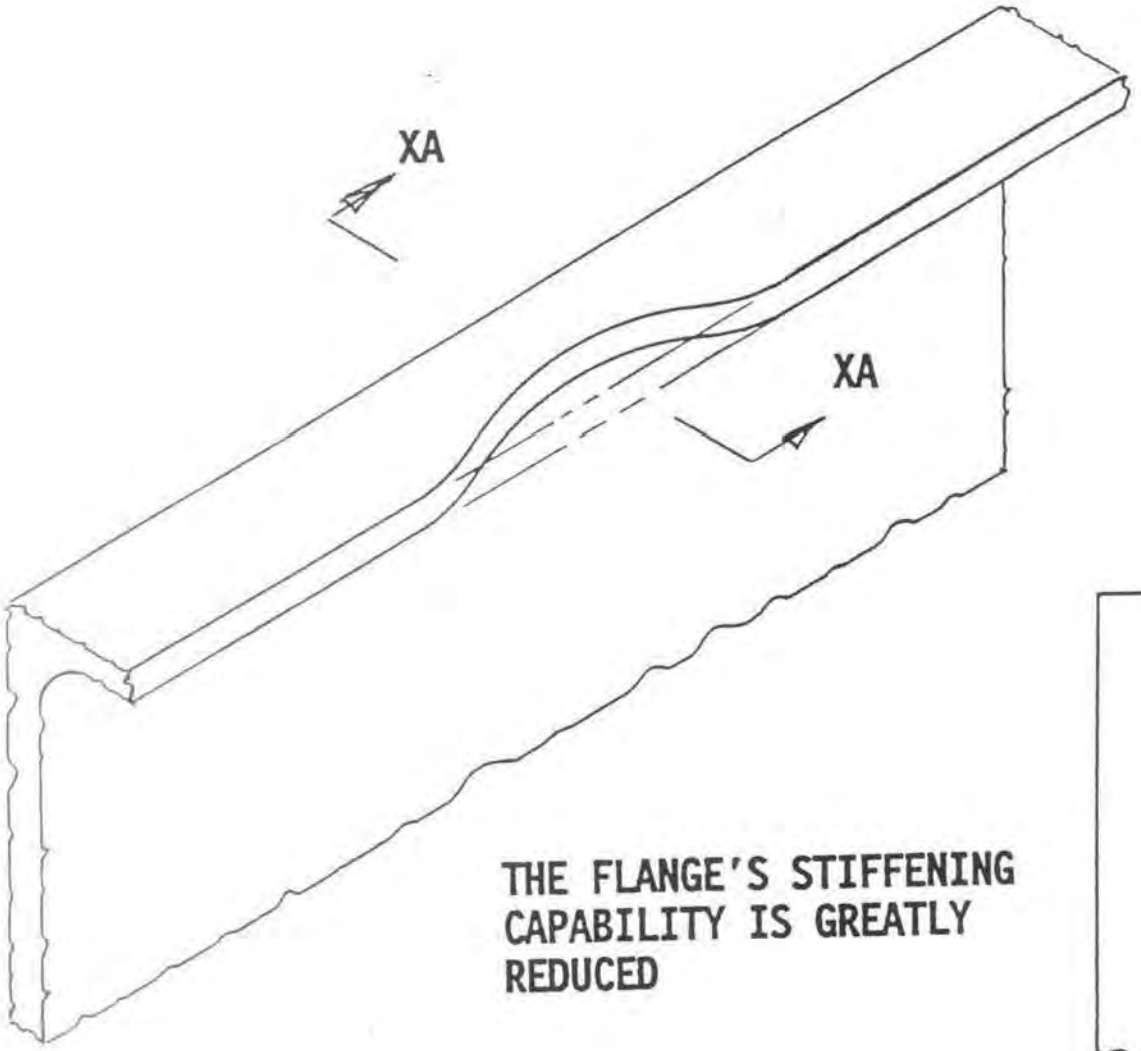
BEFORE



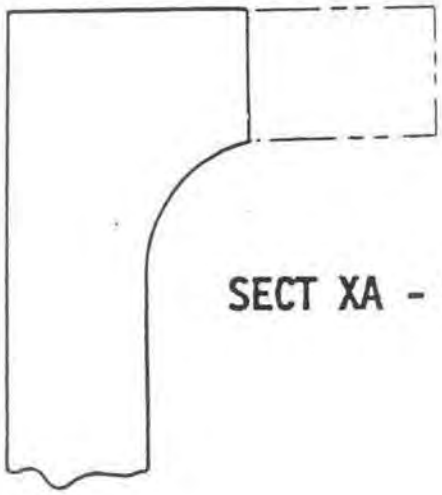


SECT XA - XA

TRIMMED RETURN FLANGES CAN HURT



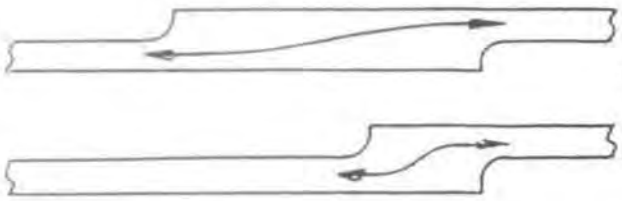
THE FLANGE'S STIFFENING CAPABILITY IS GREATLY REDUCED



SECT XA - XA

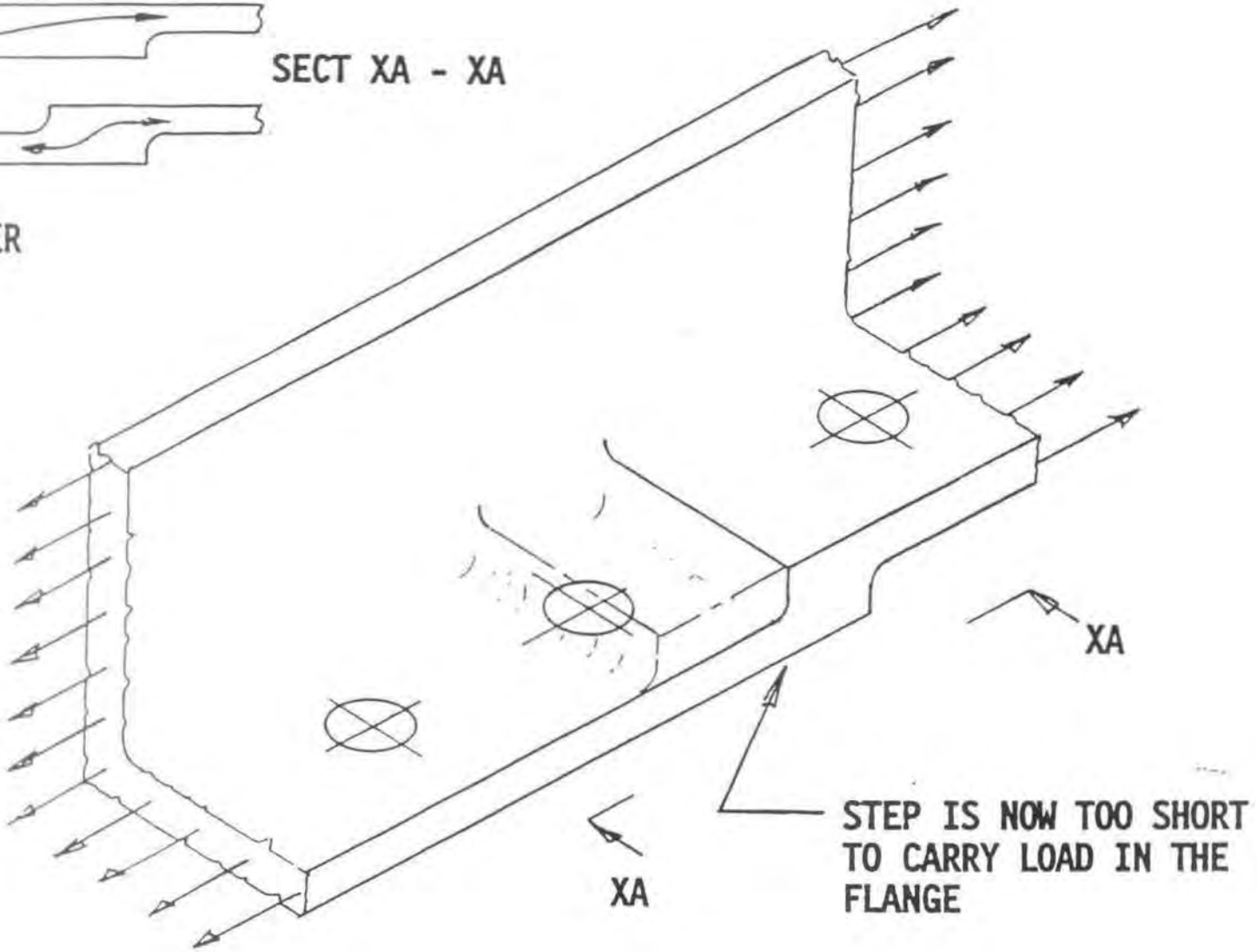
REWORKING A M. _ STEP TOO SHORT

BEFORE

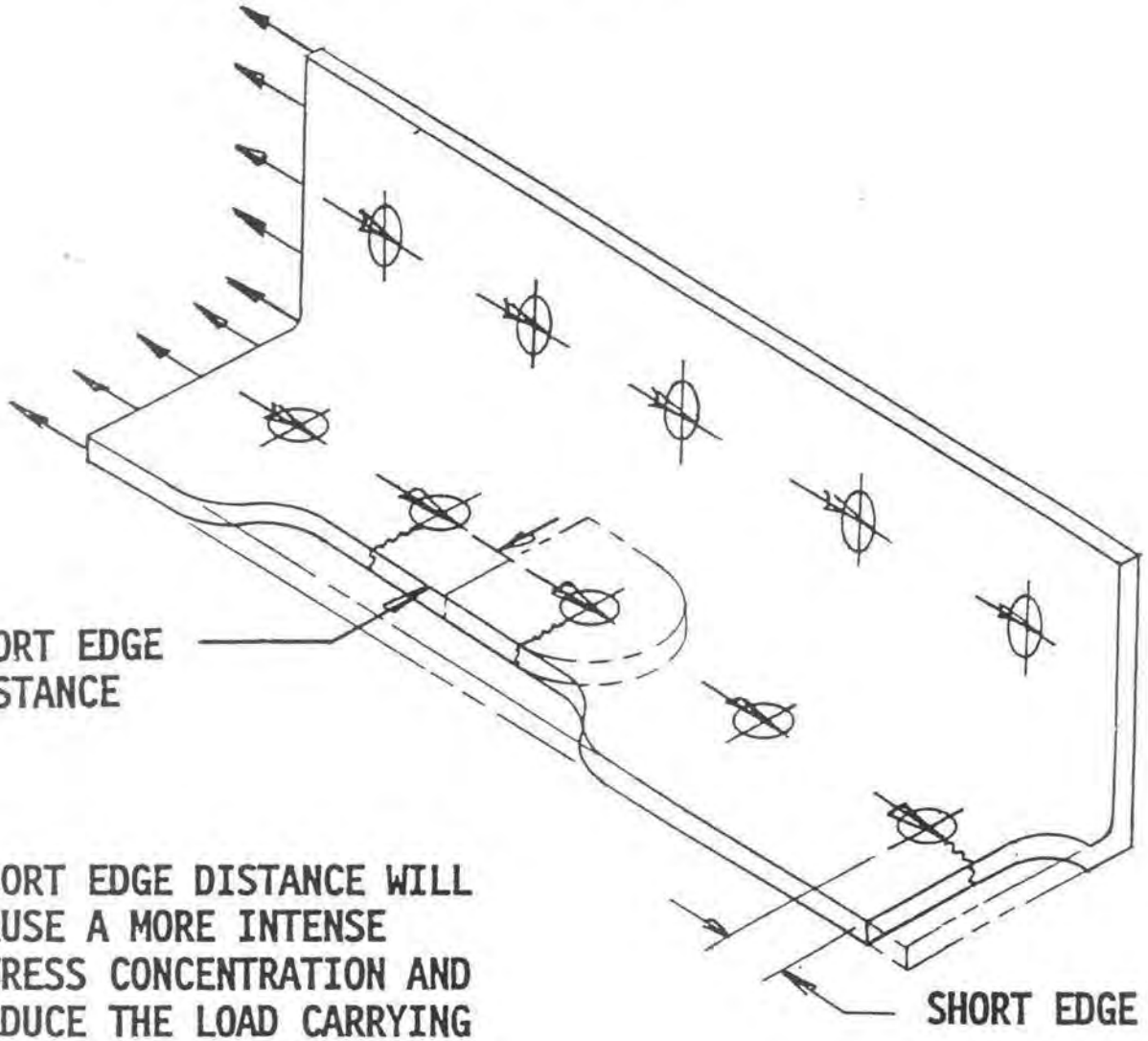


AFTER

SECT XA - XA

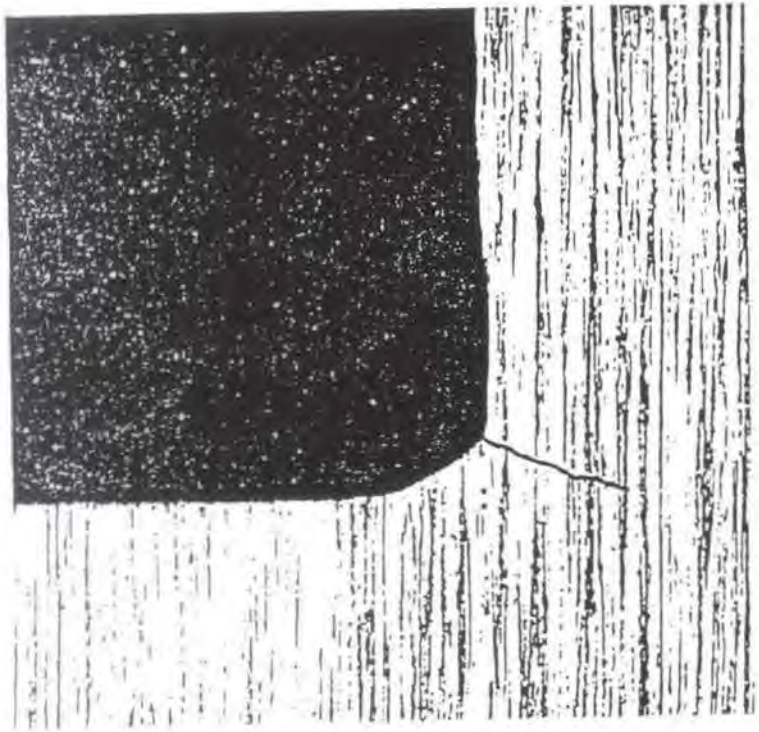


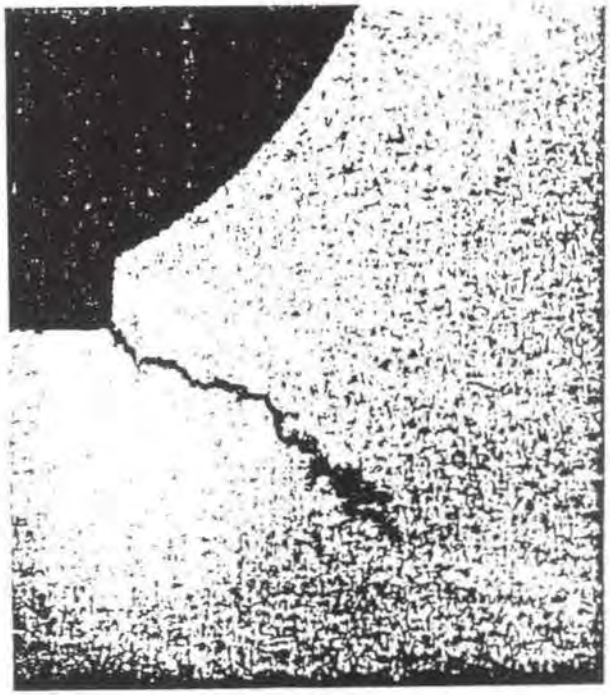
TRIMMING TOO CLOSE TO HOLES



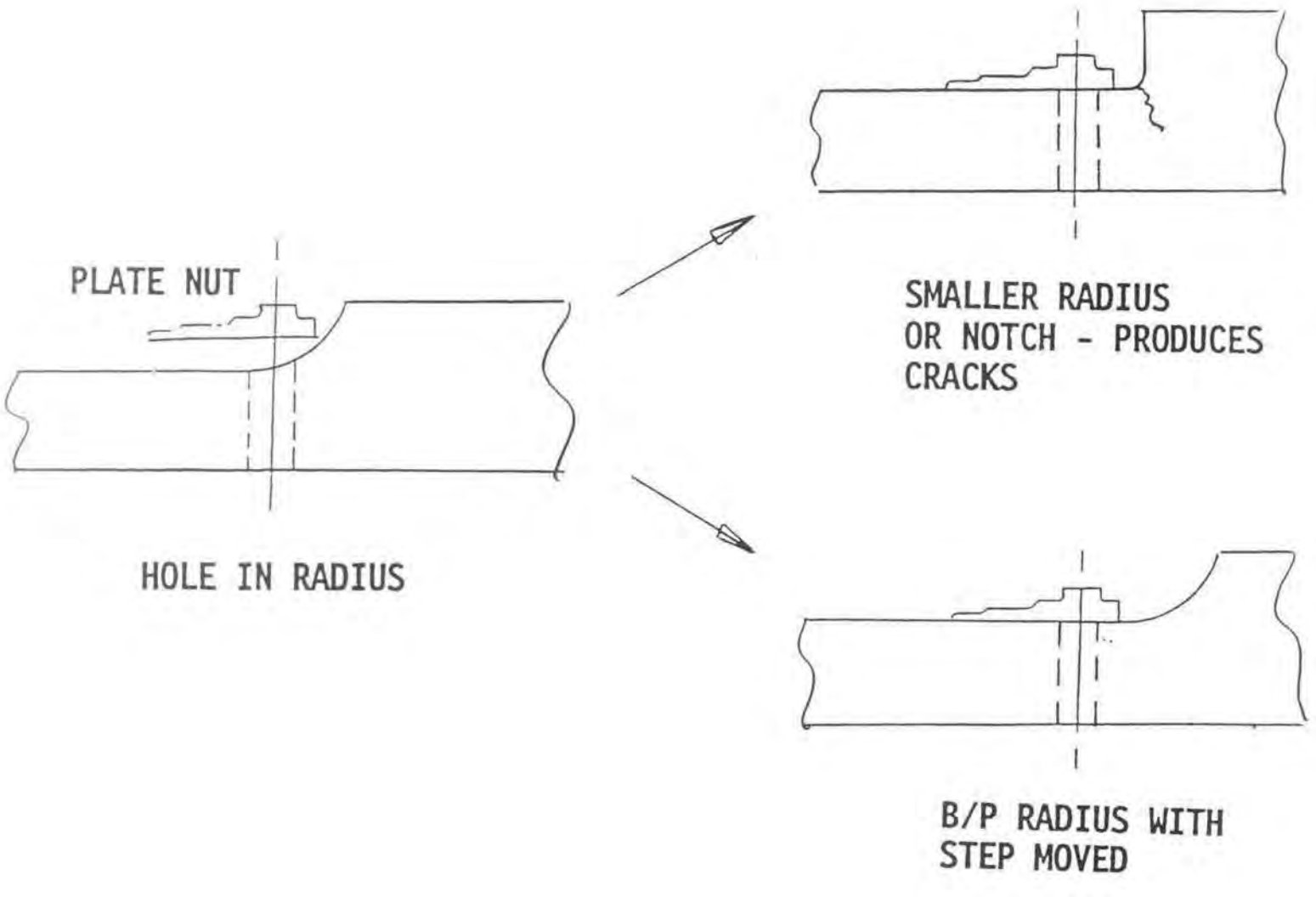
SHORT EDGE DISTANCE WILL CAUSE A MORE INTENSE STRESS CONCENTRATION AND REDUCE THE LOAD CARRYING CAPABILITY OF THE HOLE

CR CKS STARTING @ S RP CORNER RADIU

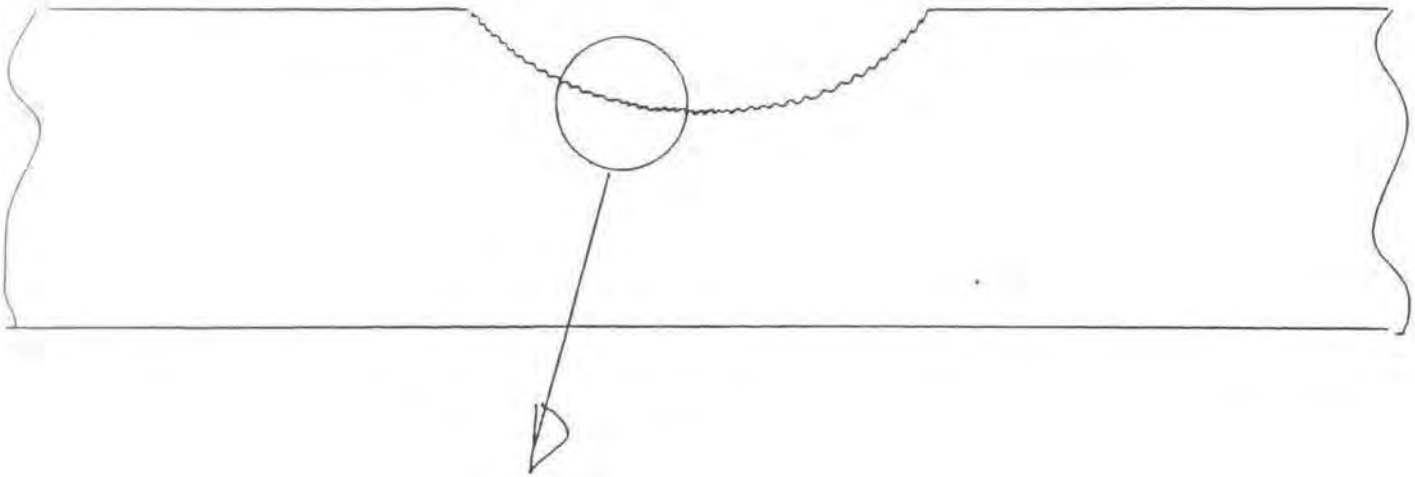


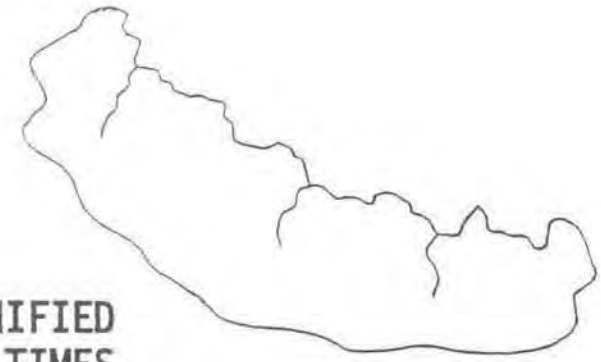


FILLET RADIUS REWORK



ROUGH SURFACE FINISH

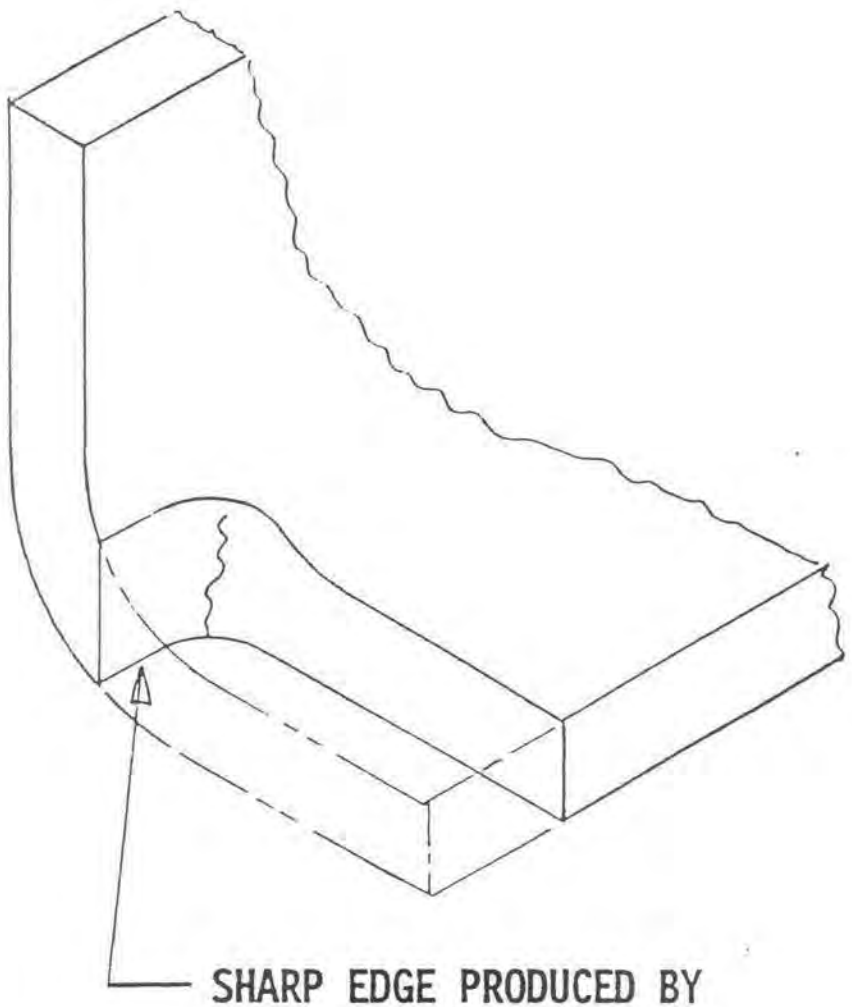




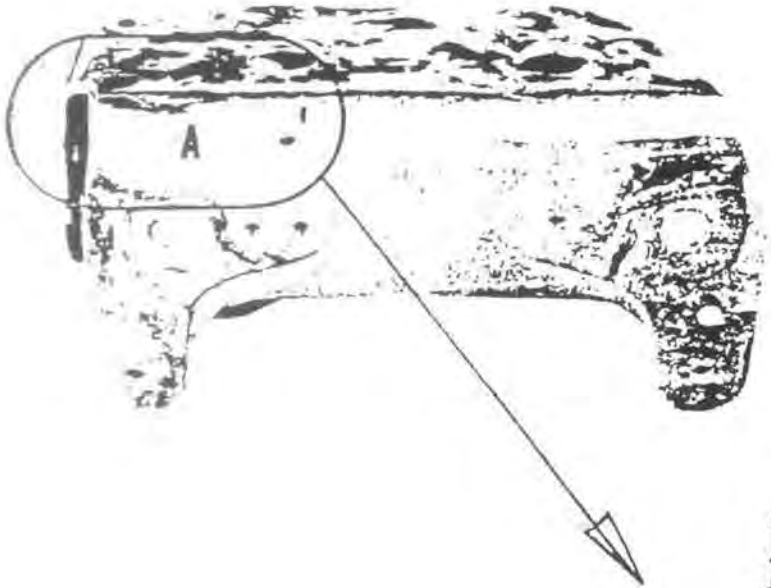
MAGNIFIED
100 TIMES

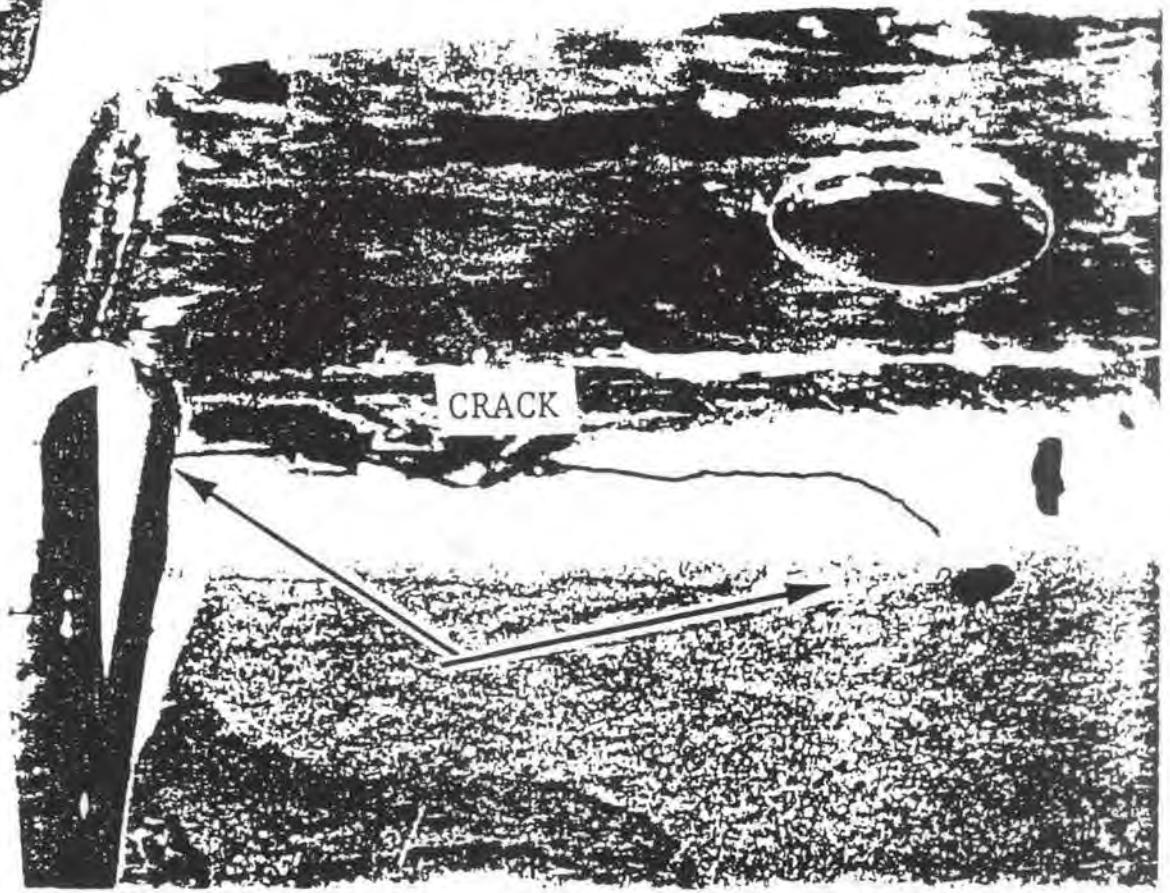
ROUGH SURFACE - A
GOOD START FOR CRACKS

MAKING SHA. EDGES



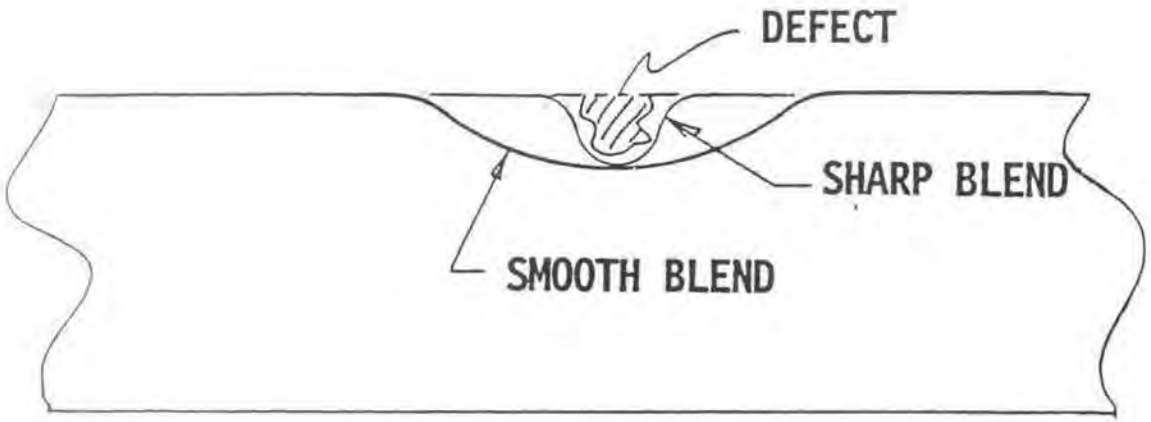
CRACK EXTENDING FROM FEATHERED EDGE





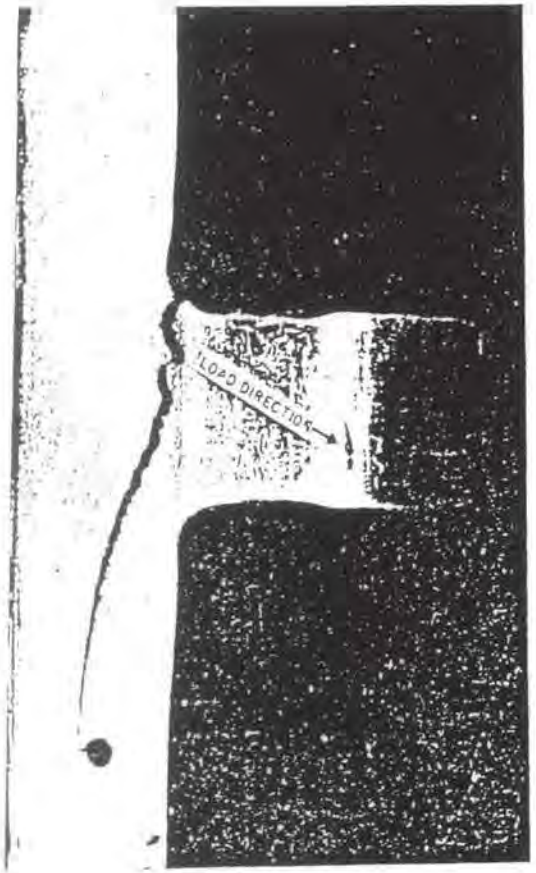
Location A

GRADUAL VS SHARP BLENDING

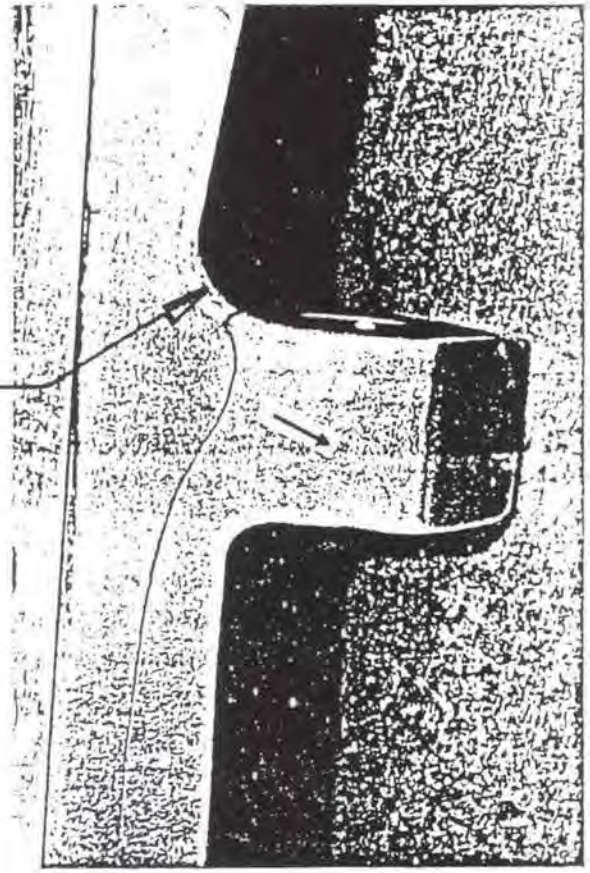


BOTH BLENDS REMOVE DEFECT
BUT SHARP BLEND MAY STILL BE
AN UNACCEPTABLE STRESS RISER -
THE STRESS INTENSITY MAY BE
TWICE AS GREAT FOR THE SHARP
BLEND AS OPPOSED TO A
SMOOTH, GRADUAL BLEND.

LUG ON F4 WI[illegible] FOLD RIB



LARGER
RADIUS



ORIGINAL LIFE = X CYCLES

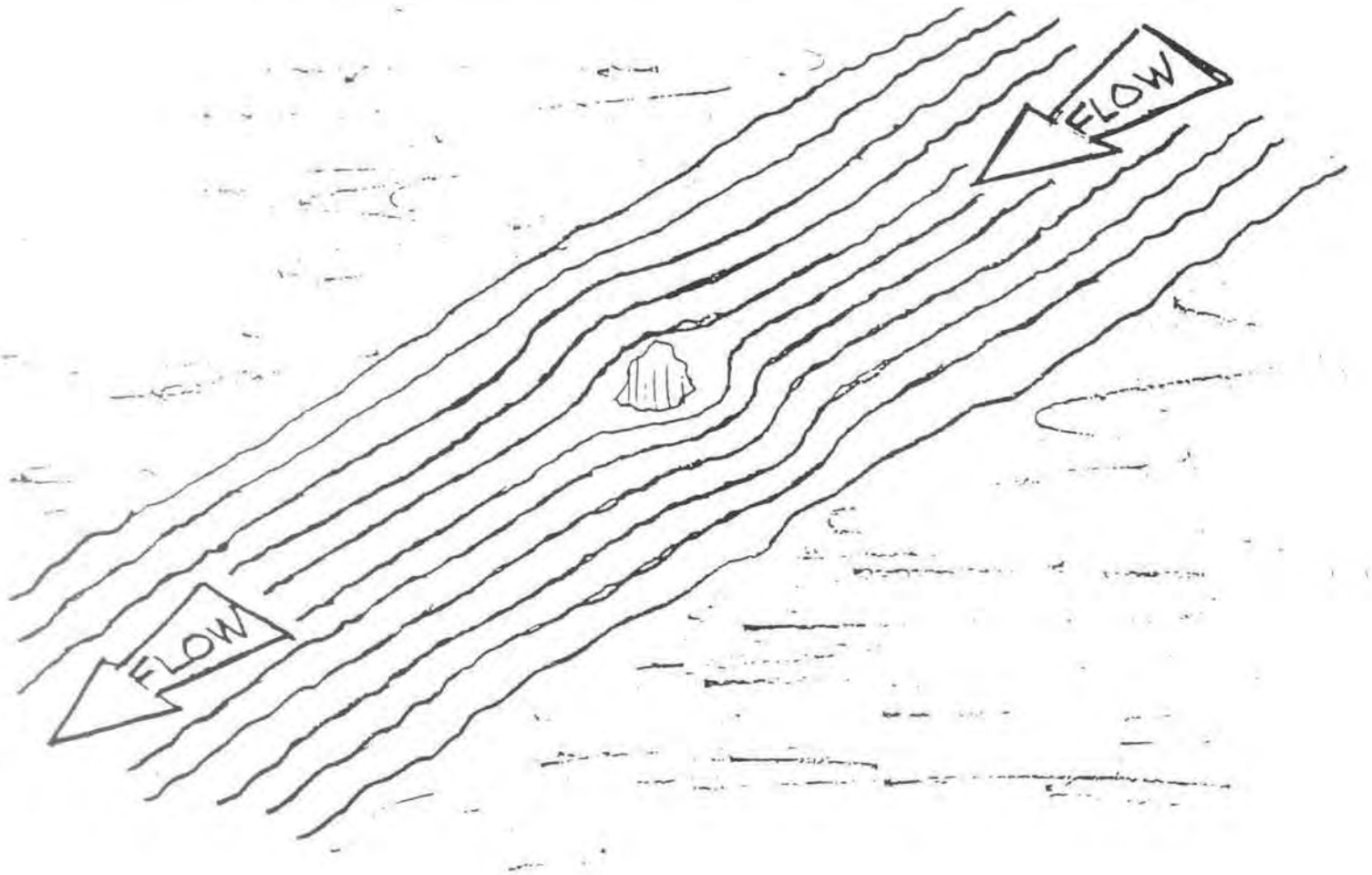
REDESIGNED LIFE = 8X CYCLES

SMOOTH, GRADUAL TRANSITIONS

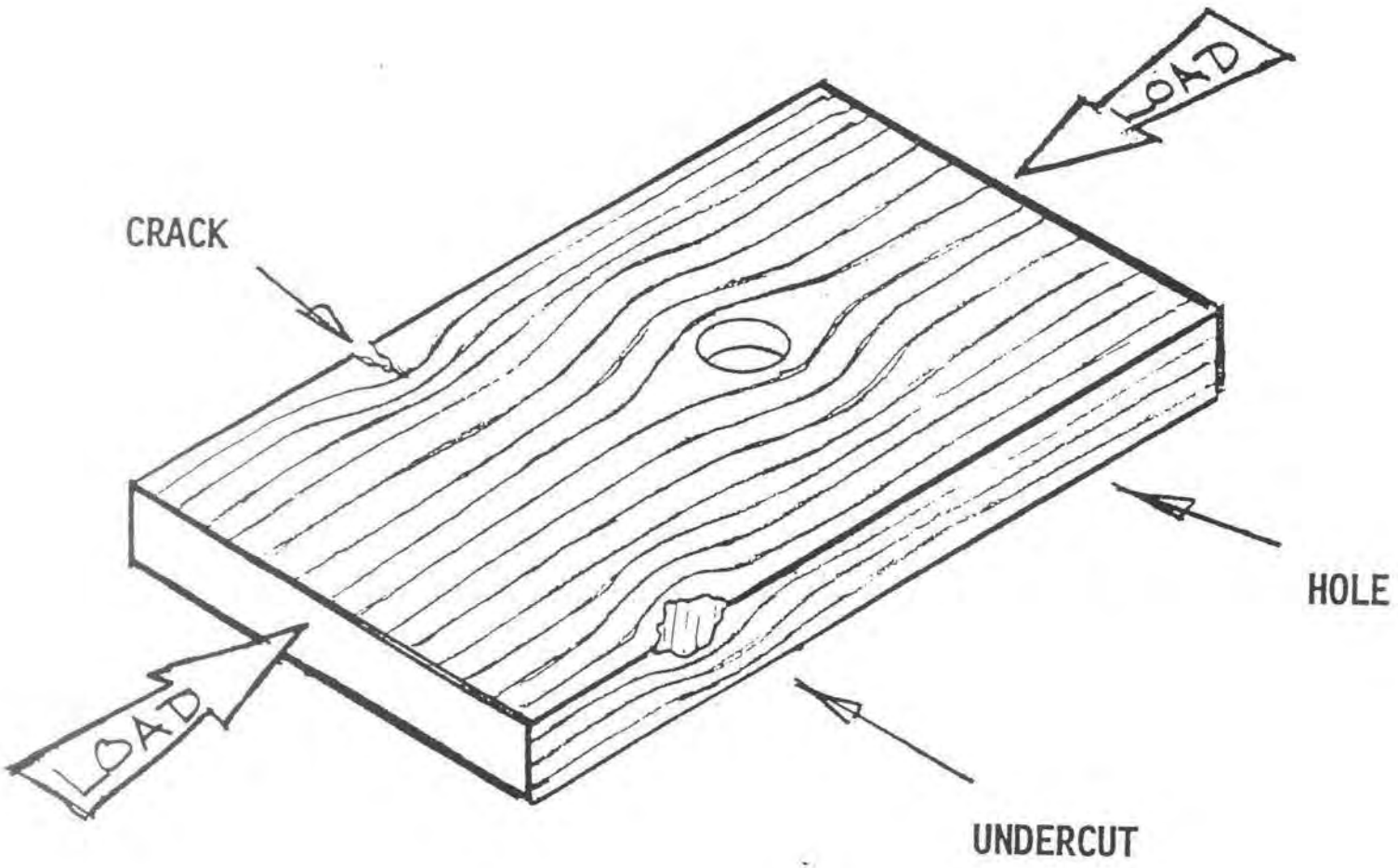
* LOAD FLOWS EASIER

* AVOIDS THE STRESS RISERS THAT CAUSE CRACKS

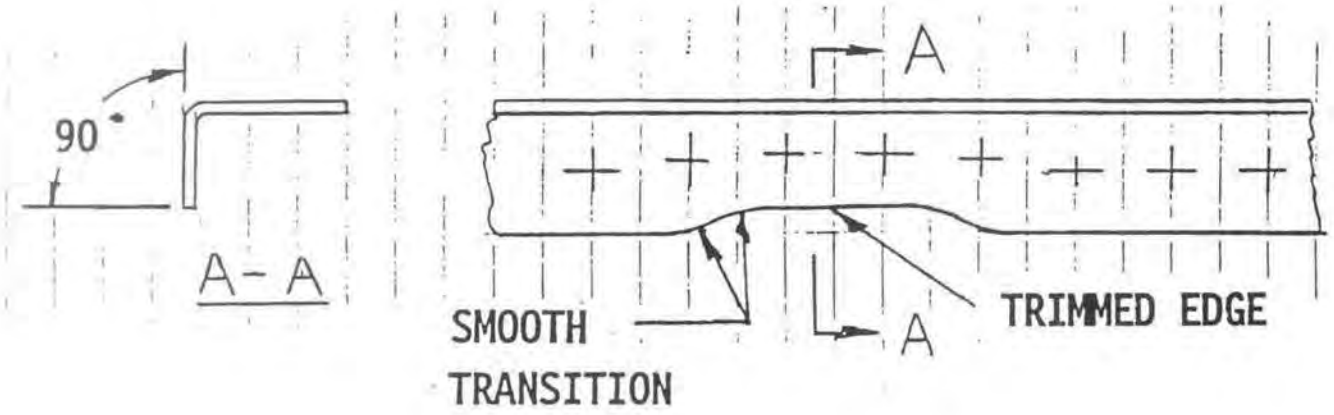
REMEMBER THE ROCK IN THE STREAM



LOAD MUST FLOW AROUND OBSTACLES

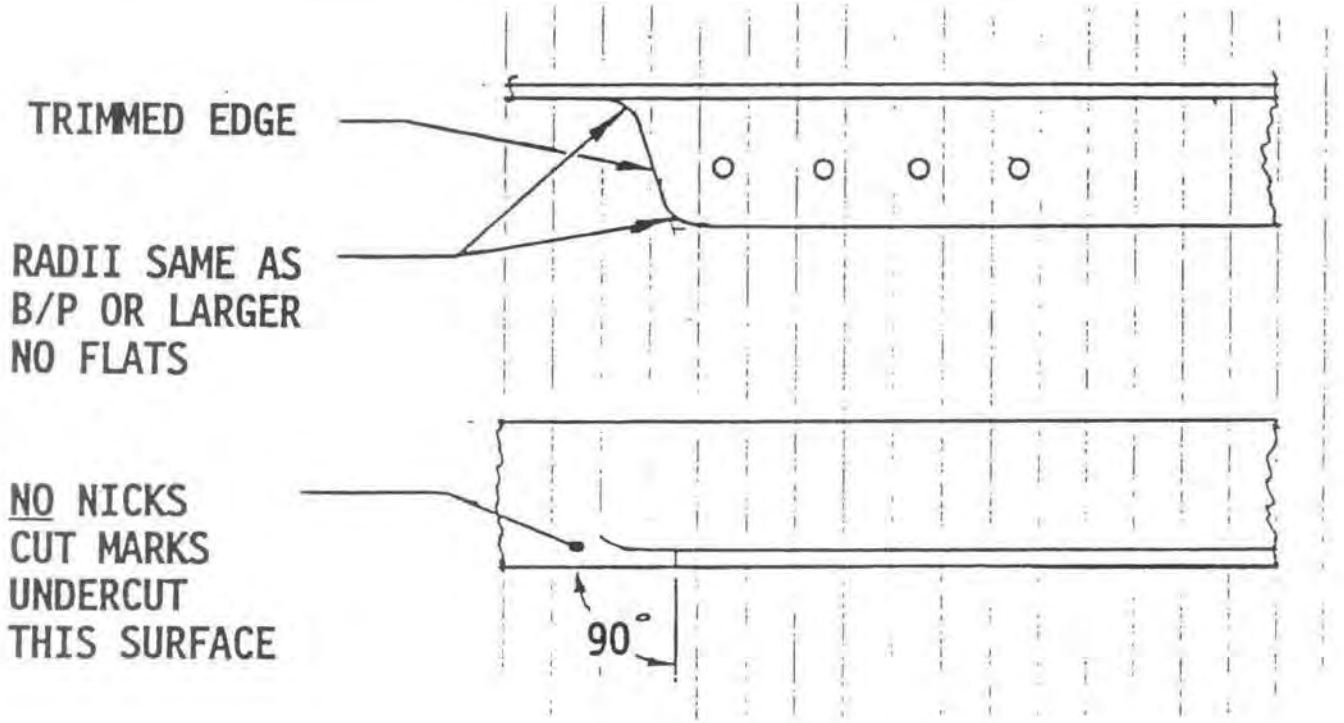


TYPICAL TRIM OF SHEET METAL OR EXTRUDED FLANGES TO PERMIT FIT UP OF PARTS



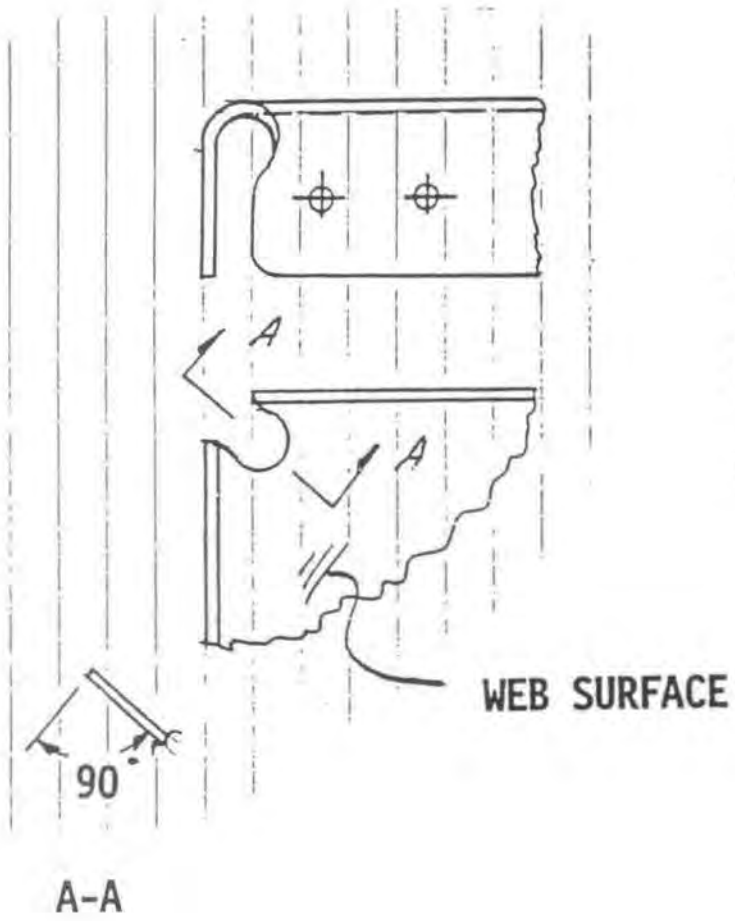
- o TRIMMED EDGE TO BE SMOOTH
- o NO NICKS OR NOTCHES
- o NO CUT MARKS
- o MAINTAIN B/P EDGE DISTANCE

TYPICAL TRIM OF EXTRUDED ANGLE TO PERMIT FIT UP OF PARTS



- o ALL SURFACES TO BE SMOOTH
- o NO NICKS OR NOTCHES
- o NO CUT MARKS
- o MAINTAIN B/P EDGE DISTANCE

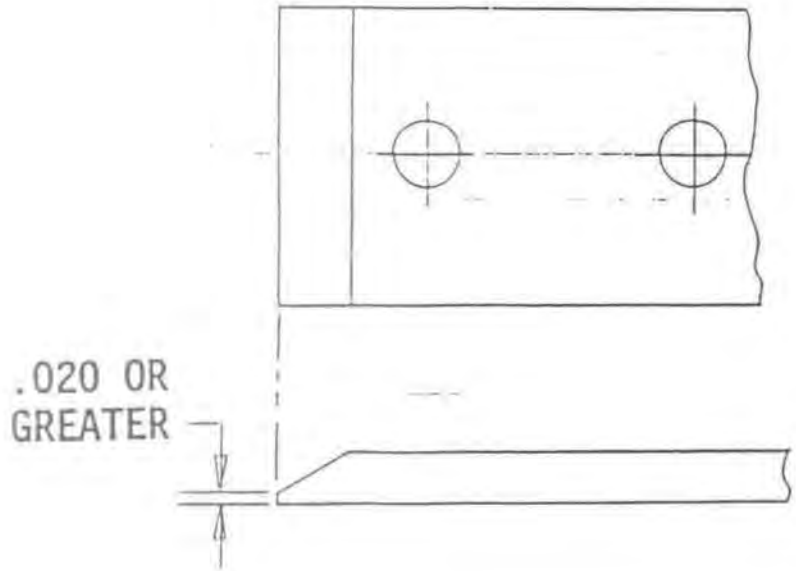
TRIMMING OF BEND RELIEF TO CLEAR ADJACENT PARTS



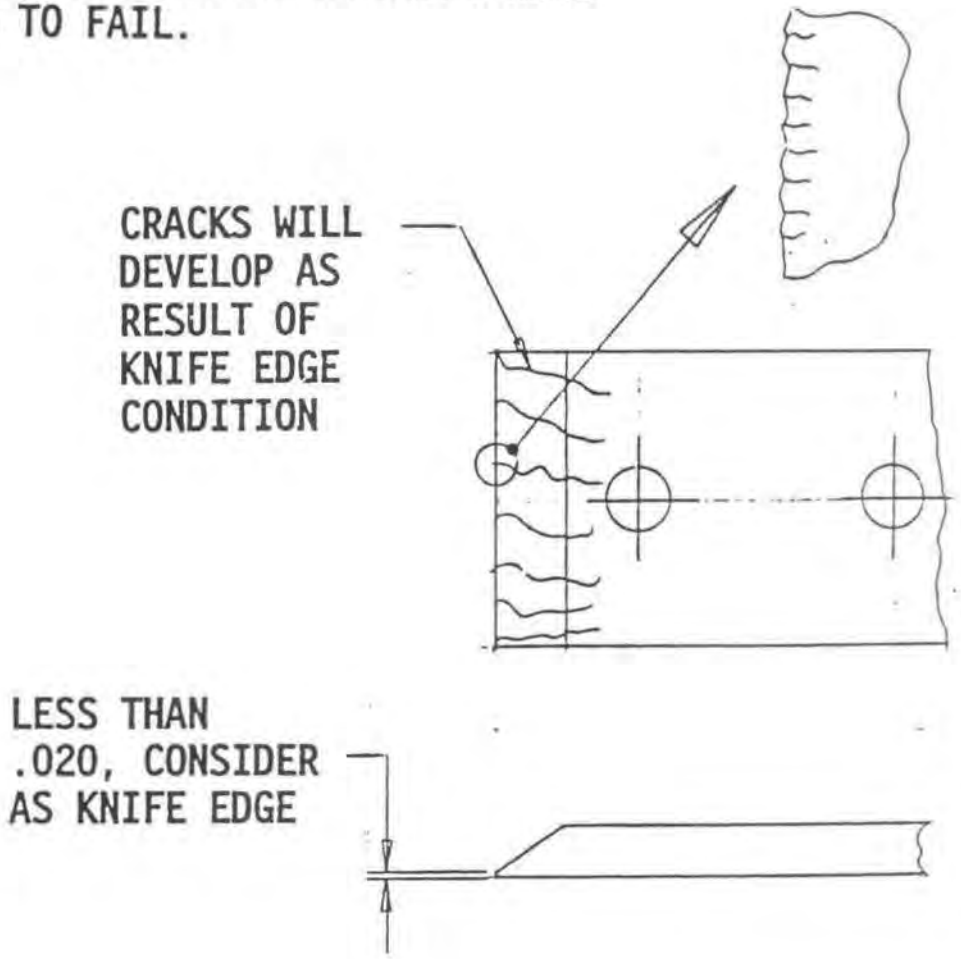
- o NO NICKS OR NOTCHES
- o CONSTANT RADIUS TRIM
- o TRIM 90° TO WEB SECT A-A
- o MAINTAIN B/P EDGE DISTANCE

GUIDE LINES FOR CHAMFERS

WHEN ADDING CHAMFER TO A PART, THE THICKNESS REMAINING MUST BE .020 OR GREATER OR CRACKING WILL DEVELOP AND CAUSE PARTS TO FAIL.

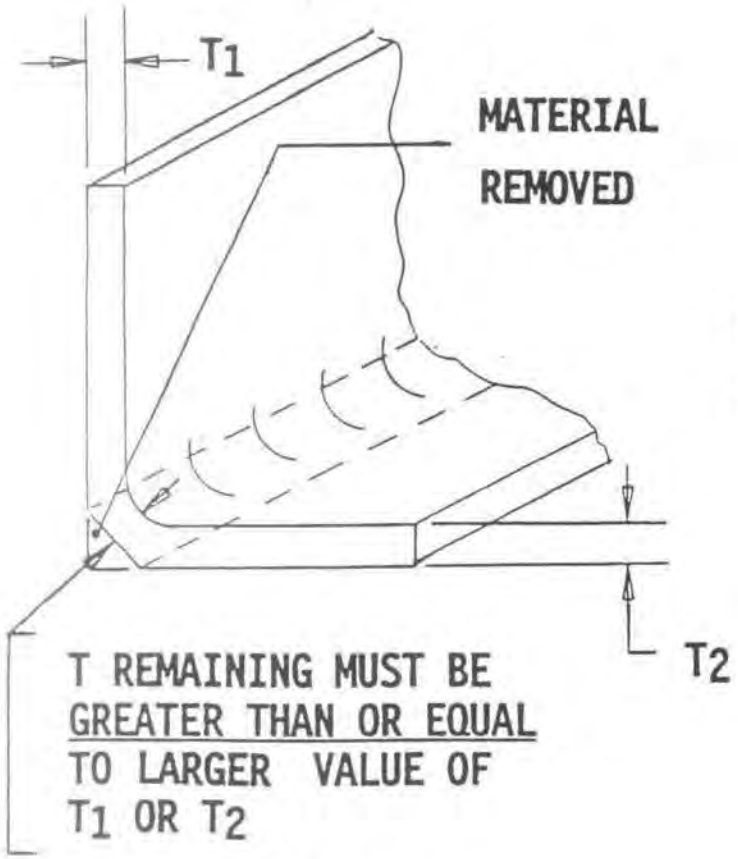


(RECOMMENDED)

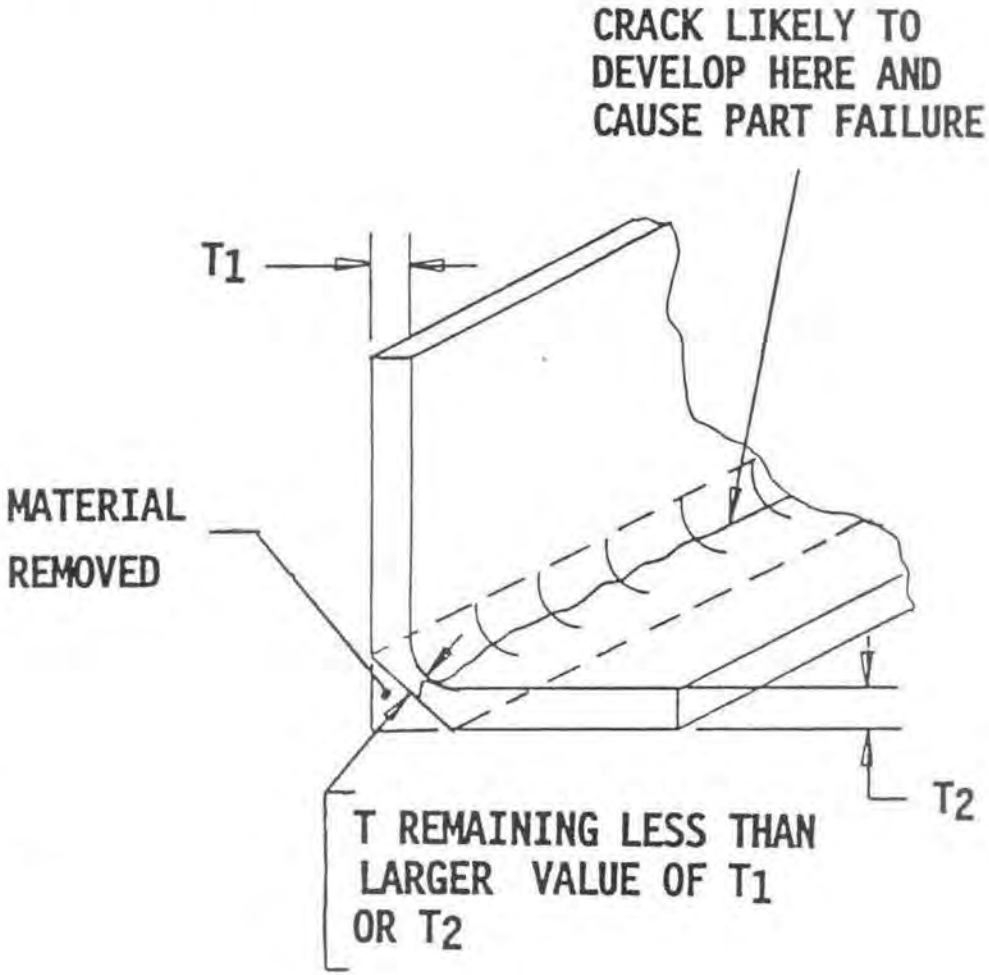


(NOT RECOMMENDED)

(GUIDE LINES ON CHAMFERS)
CHAMFERING OF INTERSECTION OF FLANGES

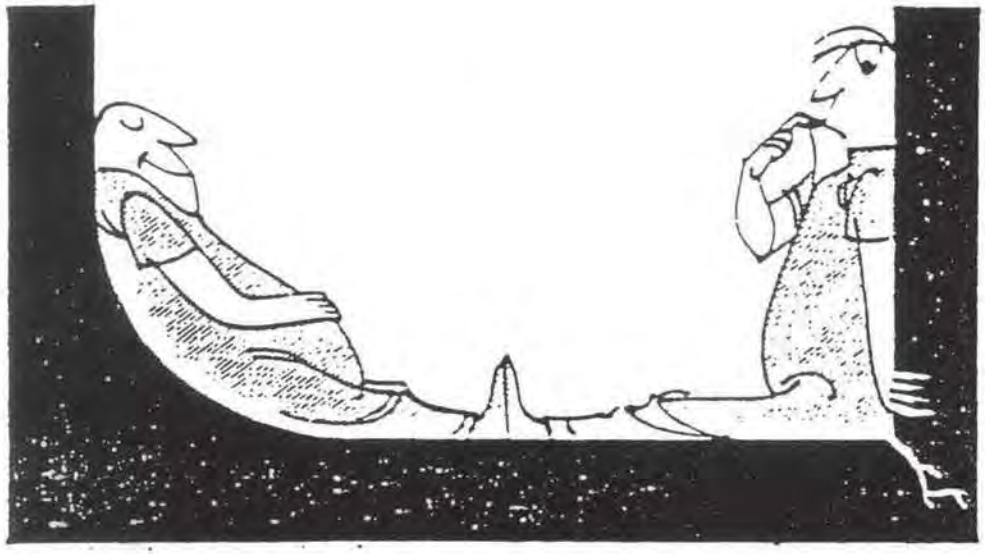


(RECOMMENDED)



(NOT RECOMMENDED)

SMOOTHER IS BETTER

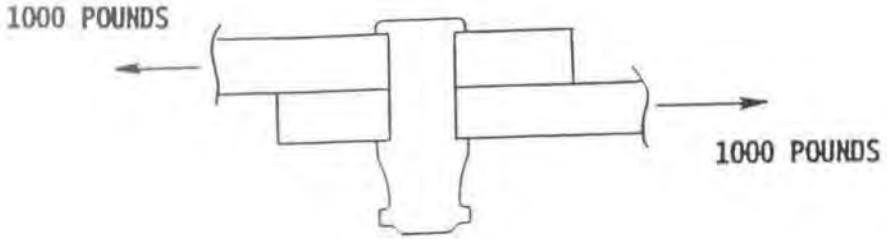


AWARENESS BRIEFING

FASTENERS

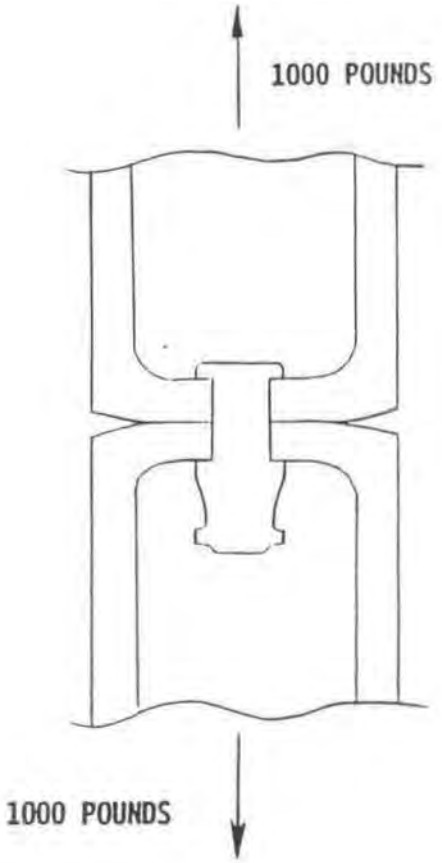
AWARENESS BRIEFING

FASTENERS WORK IN 2 WAYS



SHEAR

(MOST COMMON)



TENSION

FASTENER MATERIAL IS IMPORTANT

- A STEEL FASTENER IS OVER 3 TIMES STRONGER THAN THE SAME FASTENER MADE FROM ALUMINUM

- A TITANIUM FASTENER IS OVER 2 TIMES STRONGER THAN THE SAME FASTENER MADE FROM ALUMINUM

- ALL TYPES OF STEEL ARE NOT THE SAME

- ALL TYPES OF ALUMINUM ARE NOT THE SAME

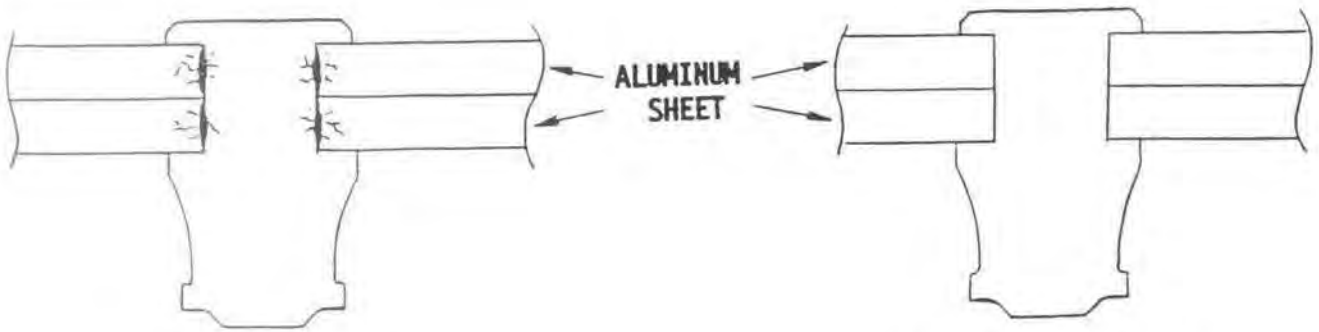
FASTENER COATINGS

WHEN CERTAIN METALS COME INTO CONTACT, CORROSION OCCURS

- SIMILAR TO THE WAY IRON RUSTS
- EXAMPLES: ALUMINUM VS STEEL; ALUMINUM VS TITANIUM

FASTENER COATINGS PREVENT THIS FROM HAPPENING

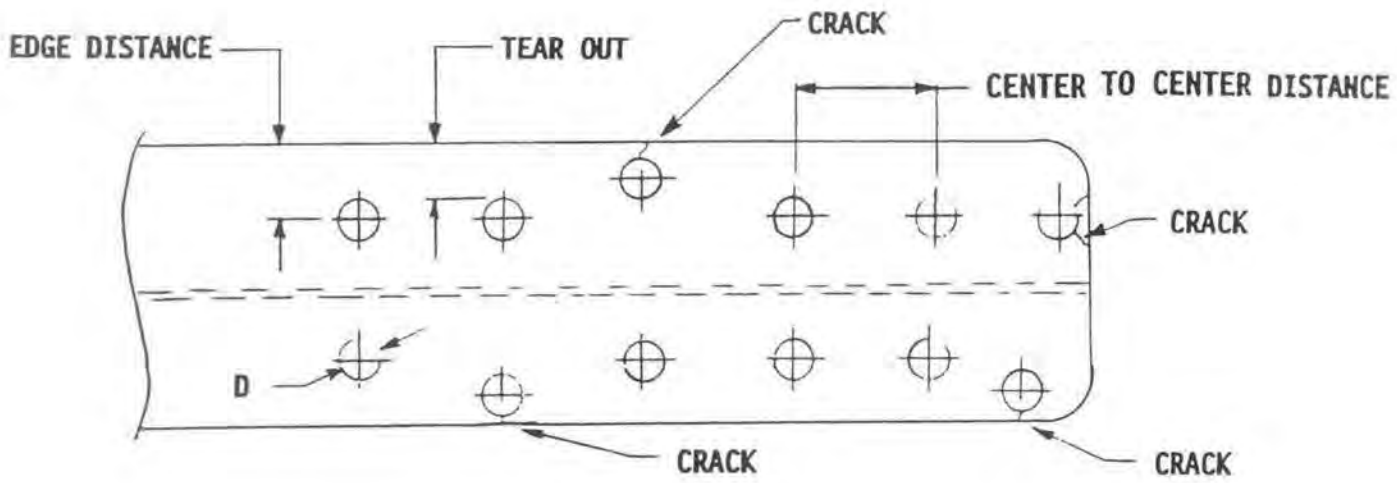
- EXAMPLES: IVD COAT, CAD PLATE, INSTALLING "WET"
- IF THE WRONG COATING IS USED, IT CAN ALSO CAUSE PROBLEMS
- EXAMPLE: CAD PLATED FASTENER IN TITANIUM IS <u>NOT</u> ACCEPTABLE



STEEL FASTENER
WITHOUT ANY COAT

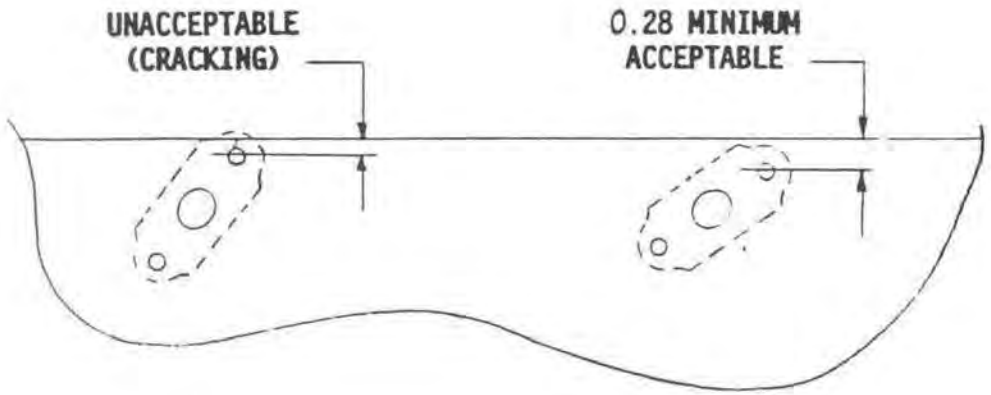
STEEL FASTENER
WITH IVD COAT

SHORT EDGE DISTANCE CAUSES CRACKS



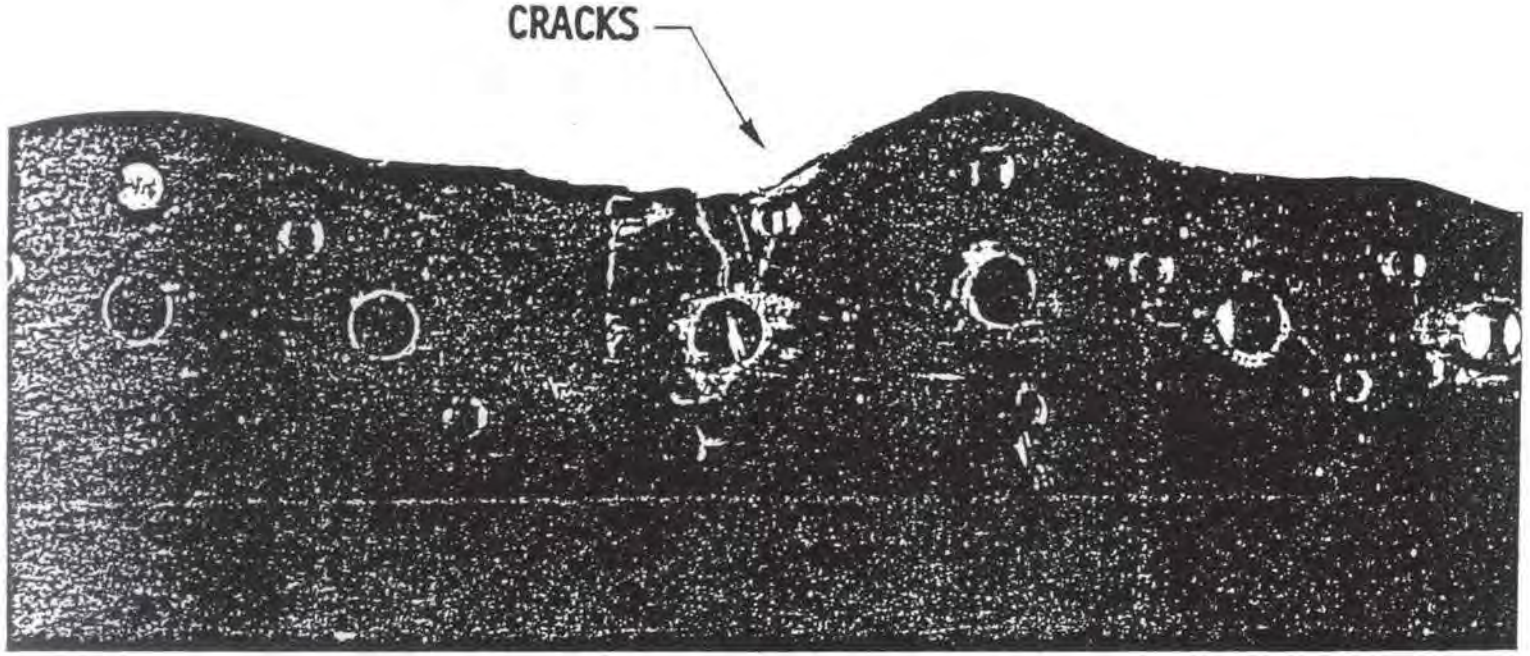
- THE SHORTER THE EDGE DISTANCE, THE HIGHER THE STRESS RISER
- THE CONSEQUENCE OF SHORT EDGE DISTANCE VARIES FROM PART TO PART
  1) IN HIGHLY LOADED PARTS, SHORT E.D. IS MUCH MORE CRITICAL
- ALL OF THIS WAS CAREFULLY CONSIDERED TO DEVELOP THE REQUIREMENT FOR 2D PLUS .03 EDGE DISTANCE
- SHORT EDGE DISTANCE IS ACCEPTABLE ONLY BY ENGINEERING DISPOSITION

THE LOCATION OF PLATENUT/MILSON RIVETS IS IMPORTANT

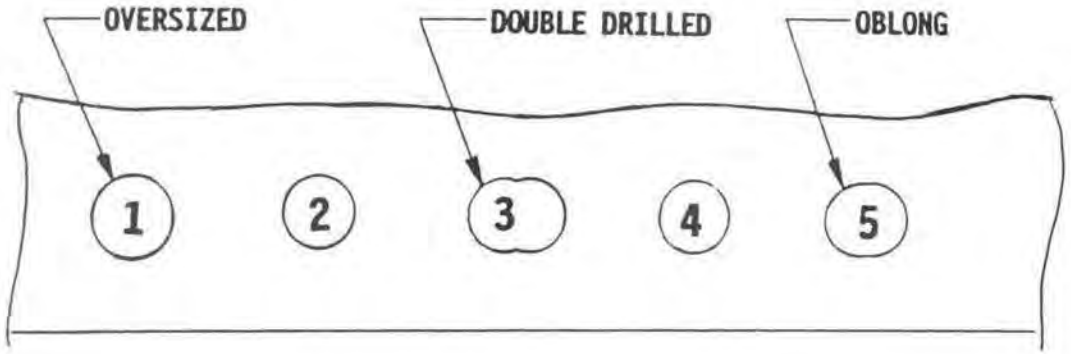


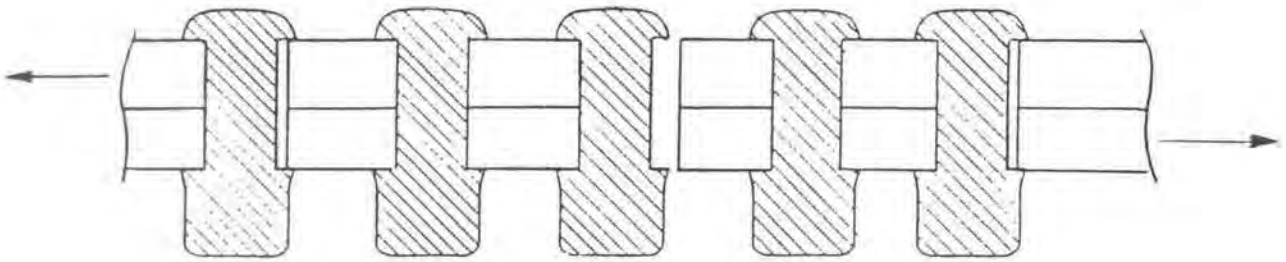
PLATENUT RIVETS ARE IMPORTANT TOO

CRACK INITIATES WHEN RIVET HAS SHORT EDGE DISTANCE



DOUBLE DRILLED, OBLONG, AND OVERSIZED HOLES MUST BE AVOIDED

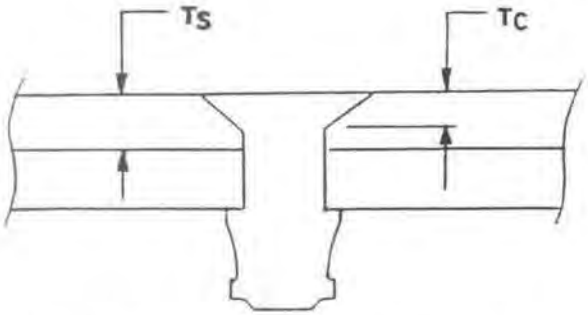




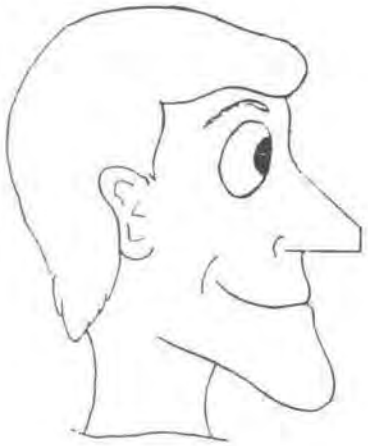
- INSTEAD OF FIVE FASTENERS HOLDING THE PARTS TOGETHER, TWO MUST DO THE JOB (#2, #4)

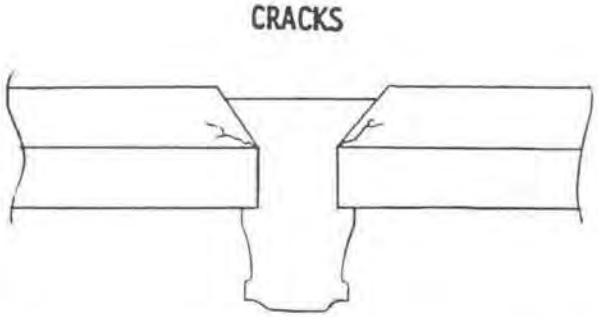
- THREE FASTENERS DON'T WORK (#1, #3, #5)

COUNTERSINK DEPTH IS IMPORTANT

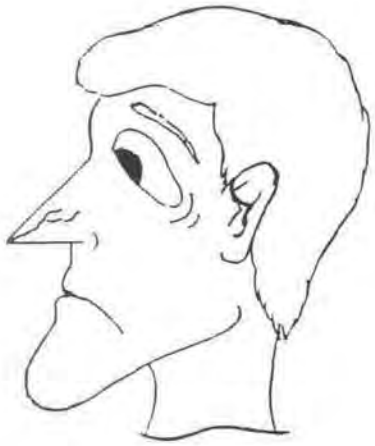


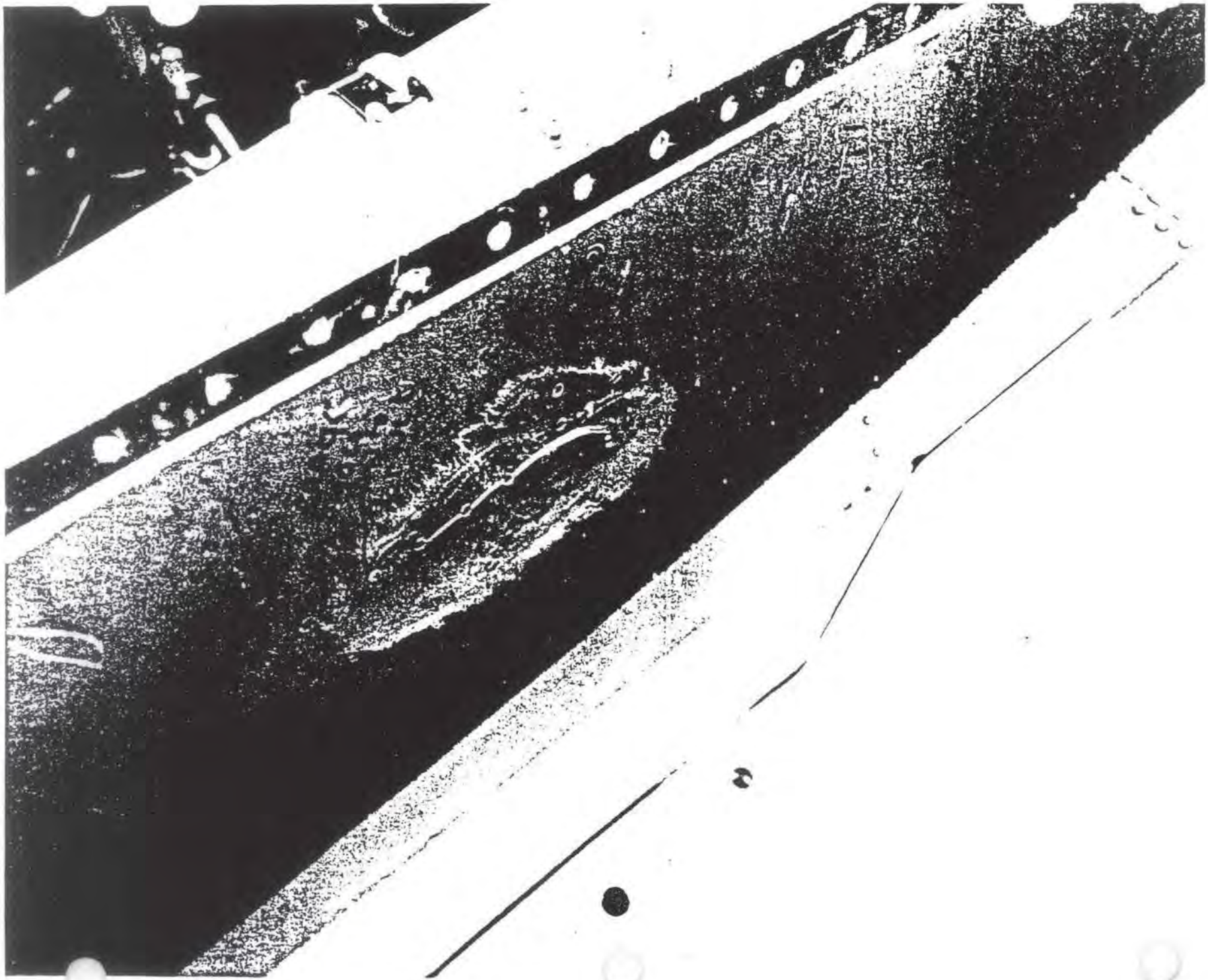
IF THE COUNTERSINK (T_C) IS LESS THAN 70% THE SHEET THICKNESS (T_S) - NO PROBLEM



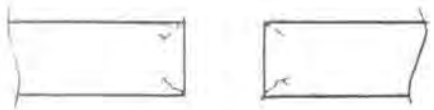


KNIFE EDGES CAUSE CRACKS - SIMILAR TO FEATHER EDGE



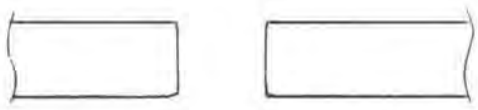


DEBURRING FASTENER HOLES

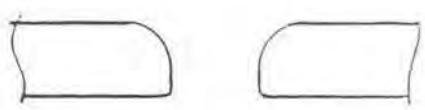


BURRS AND SHARP EDGES ARE GREAT PLACES FOR CRACKS TO START

- ROUGH, JAGGED EDGE
- ONCE A CRACK STARTS IT SPREADS INTO THE PART ITSELF.



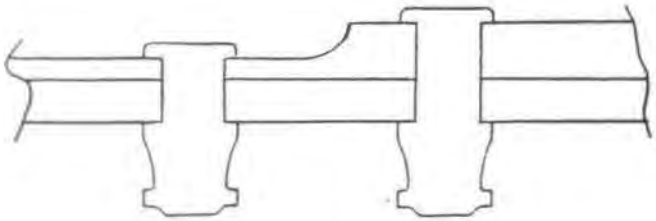
A GOOD DEBURRING SOLVES THE PROBLEM



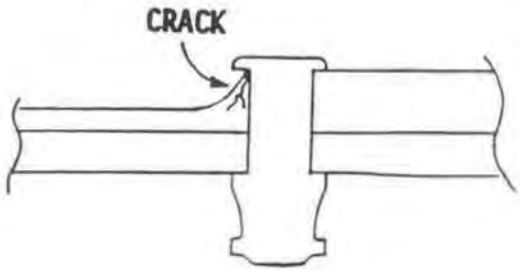
TOO MUCH ISN'T NECESSARILY A GOOD THING. OVER-DEBURRING REDUCES PART AND FASTENER STRENGTH BY REDUCING BEARING SURFACE AND ALLOWABLE FASTENER BENDING.

AWARENESS BRIEFING

FASTENERS SHOULDN'T BE TOO CLOSE TO CHEM MIL/MACHINE STEPS

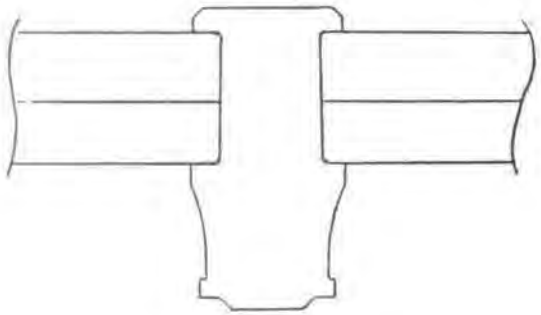


GOOD

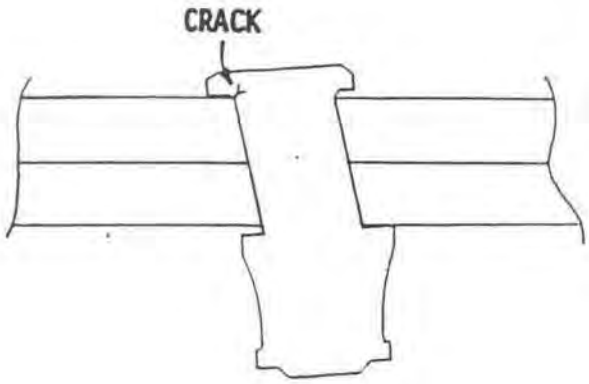


CRACKS CAN FORM

FASTENER HOLES MUST BE NORMAL TO THE HEAD SIDE SURFACE

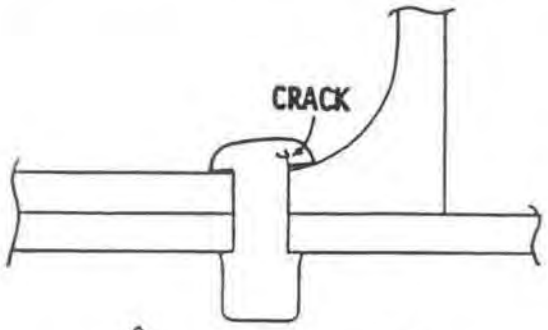


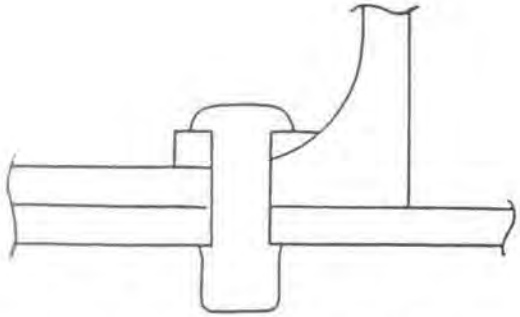
- GOOD
- NO PROBLEMS



- HEAD TILT CAN CAUSE FATIGUE CRACKING
- STANDARD NUT/COLLAR WON'T TORQUE UP PROPERLY
  - THREADS DESTROYED

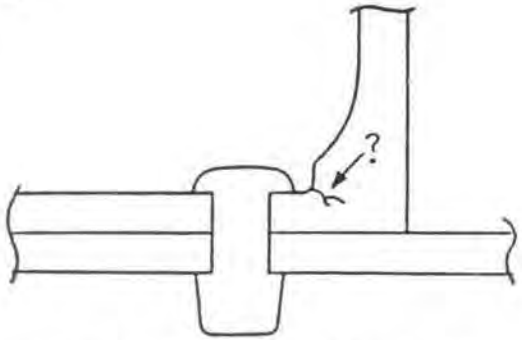
SPOT FACE/RADIUS BLOCK
MORE IMPORTANT THAN YOU MIGHT THINK





RADIUS BLOCK SOLVES PROBLEM

- MUST HAVE NEW LENGTH
- NEEDS ENGINEERING DISPOSITION

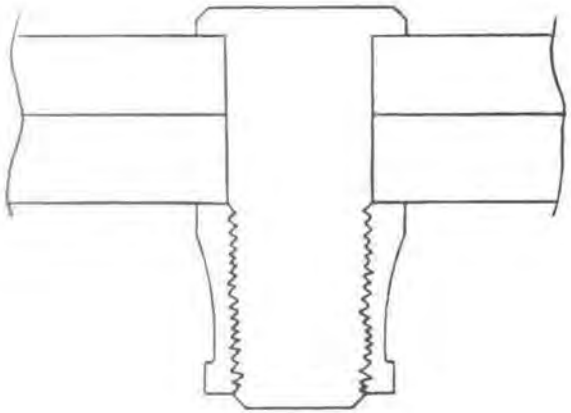


SPOT FACE SOLVES PROBLEM

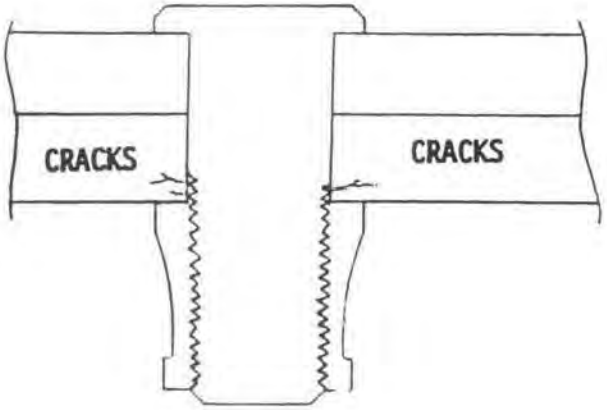
- COULD CAUSE CRACKING IN HIGHLY LOADED PARTS
- NEEDS ENGINEERING DISPOSITION

AWARENESS BRIEFING

THREADS IN STRUCTURE ARE UNACCEPTABLE



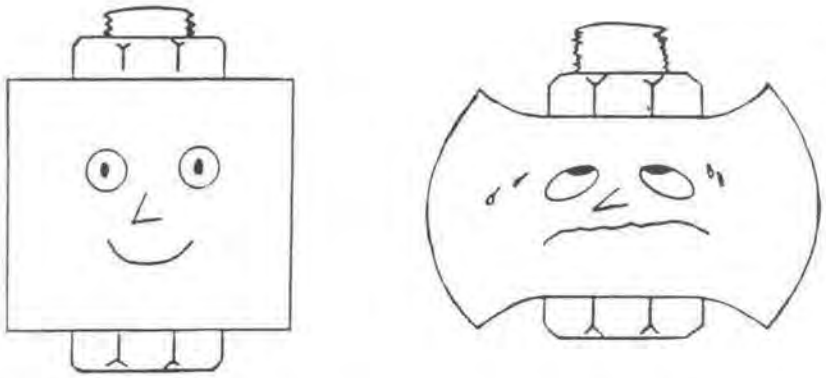
GOOD - NO THREADS IN STRUCTURE



UNACCEPTABLE - CRACKING CAN OCCUR WHERE THREAD CONTACTS STRUCTURE

FASTENER TORQUE

A) WHEN A FASTENER IS TORQUED TOO MUCH, AN ADDITIONAL LOAD (THAT IT IS NOT SUPPOSED TO GET) IS FORCED INTO IT. THIS ADDITIONAL LOAD CAN MAKE IT FAIL OVER TIME.



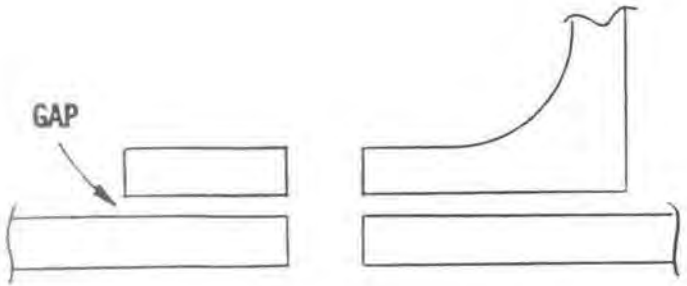
PROPERLY TORQUED OVERTORQUED

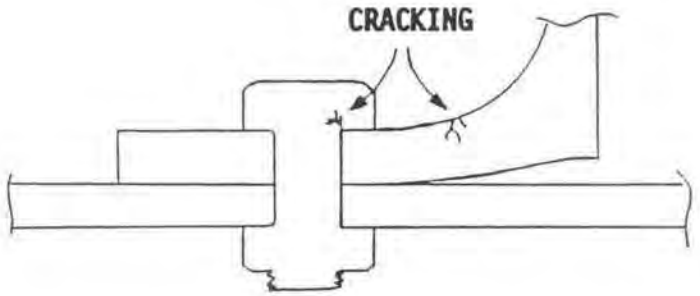
B) AN UNDERTORQUED FASTENER CAN ALSO CAUSE TROUBLE

- THE STRENGTH OF THE FASTENER IS SEVERELY DECREASED

FASTENERS SHOULD NOT BE USED
TO PULL OUT GAPS

TENSION CAUSED BY PULLING OUT GAPS CAN CAUSE PROBLEMS





GAP EXIST

- PULL OUT GAP WITH FASTENER
- FATIGUE CRACKS CAN DEVELOP DUE TO TENSION IN FASTENER
- FASTENER WAS NOT INTENDED TO PULL OUT GAPS

DOUBLE DRIVING RIVETS IS RARELY ACCEPTABLE

1) DOUBLE DRIVING (TWO RIVET GUNS, NO BUCKING BAR - A REAL SHOCKER)

   A) CAUSES CRACKING IN THE RIVETS
   B) DAMAGES THE PARTS BEING RIVETED
   C) MAY NOT FAIL UNTIL THE PLANE IS IN OPERATION
   D) ACCEPTABLE ONLY BY ENGINEERING DISPOSITION

2) STANDARD DRIVING (ONE RIVET GUN, ONE BUCKING BAR)

   A) REDUCES THE CHANCE OF THE ABOVE PROBLEMS

TRIM EN WERMENT
PB 10-573/PS 20028

* THE PROCESS BULLETIN OUTLINES THE REQUIREMENTS FOR TRIMMING SHEET METAL AND EXTRUDED METAL DETAIL PARTS TO PROVIDE COMPATIBLE FIT ON ON ASSEMBLY FOR THE F-15 ONLY.

* THE SPECIFICATION IS APPLICABLE TO SECONDARY STRUCTURE ONLY SUCH AS SHEET METAL WEBS OR SKINS AND FORMED SHEET METAL OR EXTRUDED PARTS.

* PARTS NOT CONSIDERED TO BE SECONDARY STRUCTURE ARE WING SPARS, MACHINED RIBS, MACHINED SKINS, BULKHEADS, MACHINED FORMERS, LONGERONS, STRINGERS, MACHINED FITTINGS, LANDING GEAR AND TRUNION BEAMS, STABILATOR TORQUE RIBS, SPINDLES, ETC.

* THE PROCESS BULLETIN IS NOT APPLICABLE TO INTERCHANGEABLE PARTS & IT CANNOT BE USED TO OBTAIN OPERATING CLEARANCE FOR CONTROLS MECHANISMS, TUBES, WIRE BUNDLES, ETC.

TRIM EMPOV[illegible]MENT CONT'D
PB 10-573/PS 20028

* SPECIFICATION LIMITATIONS:
  - o FASTENER PATTERNS DEFINED ON THE ENGINEERING DRAWING MUST NOT BE ALTERED.
  - o MINIMUM EDGE DISTANCE REQUIREMENTS OF THE SPECIFICATION MUST BE MAINTAINED.
  - o TRIMMING SHALL NOT REMOVE MORE THAN .060".
  - o MATERIAL THICKNESS SHALL NOT BE REDUCED (EXCEPT FOR CHAMFERING).
  - o MAINTAIN .50" MIN RADIUS ALONG TRIMMED EDGES.
  - o IF TRIM EXTENDS THROUGH AN EXISTING RADIUS, MAINTAIN THE B/P RADIUS.
  - o STIFFENING FLANGES SHALL NOT BE TRIMMED.

* THE SURFACE TREATMENT MUST BE TOUCHED UP AFTER TRIMMING... ALODINE, PRIME, PAINT, ETC.

TRIM EMPOV MENT CONT'D
PB 10-573/PS 20028

* ONE TIME TRIMS WITHIN THE GUIDELINES OF THE PROCESS BULLETIN DO NOT REQUIRE ANY TYPE OF DOCUMENTATION.

* REPETITIVE TRIMS (3 OR MORE OCCURRENCES) ARE TO BE DOCUMENTED ON THE F-15 PLANNING CALL SHEET (MDC FORM NO. 2099).

* LIAISON PLANNING AND A STRUCTURES ENGINEER WILL PERFORM AN INVESTIGATION OF THE TRIM INVESTIGATION REQUESTS NOTED ON THE PLANNING CALL SHEETS AND IF NECESSARY CAN TURN THE INVESTIGATION OVER TO THE PRODUCT TEAMS.

* CORRECTIVE ACTION CAN CONSIST OF INSTRUCTIONS TO CONTINUE TRIMMING (BY NOTE IN THE PLANNING ASSEMBLY ORDER), A TOOLING CHANGE, AN ENGINEERING ORDER, ETC.