Aircraft SHEET METAL WORK

- Prem Mahendranathan-
STRUCTURAL REPAIR

Structural repair can be classified as

- Corrosion Repair
- Modifications
- Interior Cabinet
- Stainless Steel Container Fabrication
- Part Fabrication
STRUCTURAL REPAIR

Structural repair involves
- Modification
- Welding
- Composites
- Structures D.E.R.
- Aircraft Fuel Tank Bladder Repair
- Airport Ground Equipment Repair
AIRCRAFT STRUCTURE: MATERIALS

- Aluminum Alloys
- Titanium
- Composite
While making a structural repair, following parameters should be maintained as original:

- structural strength
- design
- safety standards
- cosmetic appearance

A perfect repair may reduce further cracks.
THIS COULD BE REPAIRED TOO

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BASIC PRINCIPLES OF SHEET METAL REPAIR

- Examine
  - Evaluate
- Plan
  - Estimate
  - Execute

“Sizing Up”
EXAMINE THE DAMAGE

- Examine
  - the damage visually
  - the load damage
  - the supporting structural members
  - closely for partially failed rivets
  - for elongated holes
  - for corrosion damage
  - the white crystalline deposits around the loose rivets
EVALUATE THE DAMAGE

- Location?
  - Primary
  - Secondary

- Extent of the damage

- “Cleanout” area
SHEET METAL WORK

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PLANNING

- Repair scheme
- Type of material
- Rivet type and quantity
- Rivet pattern
- Duration
- Skilled personal
ESTIMATE

- Material cost
  - Rivets cost

- Required man-hour
  - Profit loss due to grounded aircraft
    - Material and components arrival time
    - Time required to complete the work
EXECUTE

- Clean the damage area
- Cutout the corners into oval or circular shape
- Make a template using paper
- Select the appropriate material
- Identify the rivet pattern
- Rivet the material to the structure.
FIRST THING FIRST: SAFETY

Wear
- Safety Glass
- Ear plugs
- Gloves
- Cloths
CLASS ROOM TOOLS REQUIRED

- Calculator
- Machinist's Ruler (1/32, 1/64, 1/100)
- Compass
- Right angle or triangle
- Marking tool (No lead pencil)
WORKSHOP TOOLS

- Drill bits:
- Center punch
- Sharpie - Ultra Fine – (no pencil for marking)
- Files (round, half round, flat)
- Scrape of wood
- Deburring tool
- Rivet Gun
- Clamps
- Tape
AIRCRAFT RIVETS

Universal head  100° Csk. head  Round head  Flat head
RIVET GUN, SNAPS AND BUCKING BARS

Image source: overthehills.com
HOLDING RIVET GUN AND BUCKING BAR

Image source: hotrod.com
STEP 1: STOP DRILL
STEP 2: PATCHING PROCEDURE
DAMAGED AREA
CUT OUT THE DAMAGED AREA
MAKE A PATCH PLATE
MAKE A DOUBLER TO COVER THE PATCH
RIVETS LAYOUT PATTERN

- Rivet Spacing
  - 6D Distance Between Rows 6D
- Rivet Spacing
  - 6D Distance Between Rows 3D
- Rivet Spacing
  - 4D Distance Between Rows 4D
RIVET THE FOUR CORNERS
EDGE DISTANCE

**Incorrect - too close to edge**

E = 1½D

**Correct E = 2D**

**Resultant crack**

**Safe**

<table>
<thead>
<tr>
<th>Edge Distance/Edge Margin</th>
<th>Minimum Edge Distance</th>
<th>Preferred Edge Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protruding head rivets</td>
<td>2 D</td>
<td>2 D + 1/16”</td>
</tr>
<tr>
<td>Countersunk rivets</td>
<td>2½ D</td>
<td>2½ D + 1/16”</td>
</tr>
</tbody>
</table>
RIVET
RIVETS LAYOUT
COMPLETE JOB
BASIC PRINCIPLES OF SHEET METAL REPAIR

- Maintain the original strength
- Maintain the original contour
- Keep the weight to a minimum
MAINTAIN THE ORIGINAL STRENGTH

- The patch plate should have a cross-sectional area
  - equal to or greater than that of the original damage
- Place a splice, where the member is subjected to compression or bending loads
- Cutout radius; not no smaller than 1/2inch
- Material used; same as the original

Cont....
If it is necessary to use an alloy weaker than the original, use
- a material of **heavier gauge** to equivalent strength

If 2024-T were substituted with 2024-T80
- 2024-T shall be higher gauge (thicker).

Normally go for 1 gauge higher
- Ex. 0.32; use 0.40; use 0.50
Heat treated or cold worked alloys are hard to bend; they will crack – Ex, T2, T3 type material....

Soft alloys are easily formed but not strong enough to use in the primary structure. – “O” type material

Strong alloys are formed in annealed condition and heat treaded to develop their strength before assembling
RIVET size

- Multiply the thickness of the skin by three and next larger size rivet corresponding to that figure
  - Ex. Skin thickness - 0.040-in
    - $0.040 \times 3 = 0.120$
    - use the next larger size rivet; 1/8 (0.125)
RIVETS QUANTITY

- Formula to calculate rivets quantity
  - Number of rivets required on each side of the break =
    - \( L \times T \times \frac{75000}{S \text{ or } B} \)
    - \( L \)- Length of the break
    - \( T \)- Thickness of the material
    - \( S \)- Shear Strength
    - \( B \)- Bearing Strength
  - Thickness is measured in *thousands of inch*
Example - 1

Rivet Quantity

- Using the formula, determine the number of 2117-T rivets needed to repair a break 2-1/4 in. long in material 0.040-in. thick:
Answer 1

- L * T * 75,000 / S or B
- Given:
  - L = 2-1/4 (2.25) in
  - T = 0.040 in
  - S = 331 or B = 410
  - (2.25 * 0.040 * 75000) / 331
  - =6750 / 331
  - = 20.39 (or 21)
- Total number of rivets required = 21+21= 42
- Rivet size = 0.040 * 3 = 0.120, so rivet size is 1/8
BASIC PRINCIPLES OF SHEET METAL REPAIR

- Maintain original strength
- Maintaining Original Contour
- Keeping Weight to a Minimum
MAINTAINING ORIGINAL STRENGTH

- Make a repair in such a way that it should bring back the original structural strength as close as possible
Form all repairs in such a manner that they will fit the original contour perfectly.

A smooth contour is desirable when making patches on the smooth external surface on high speed aircraft.
KEEPING WEIGHT TO A MINIMUM

- Keep the weight of all repairs to a minimum
- Make the size of the patches as small as practicable
- Don’t use more rivets than necessary
- Repairs disturb the original balance; may require additional weight or adjustment on trim- and balance tabs
- Repairs on prop spinner, require application of balancing patches; for perfect balance

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