

Improving Operational repairability through SRM development

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STRUCTURAL REPAIR MANUALS

- Rarely keeps up with service experience
- Can lag behind in materials, process, methods and environmental technologies.
- Frequently ambiguous, generally confusing, often inconsistent
- Too restrictive with arbitrary allowables
- written in “Simplified” English

STRUCTURAL REPAIR MANUALS

2001 SRM Vacuum repair restriction, quote,

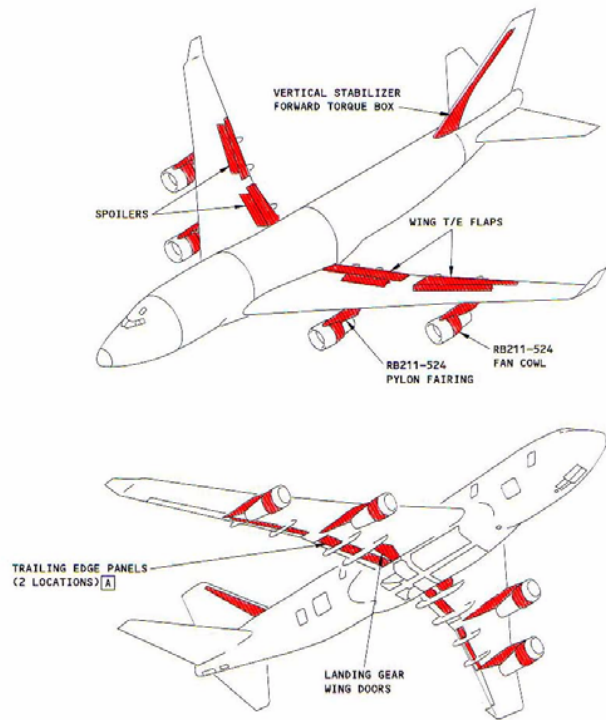
“Because the vacuum bag can only supply a small amount of pressure (approx 10-12 psi) and because a nominal pressure of 35 psi necessary to bond critical areas sufficiently, **you are only allowed** to use this method, if you meet these specific repair conditions”.


- **“Repairs that have no compound curvature”**
- **“Repair areas that have no irregular flatness changes in local areas”**
- **“Repair areas that have less than 0.1 inch change in contour in any 12 inch length- this 0.1 inch change must be in a single increase or decrease in one direction along the surface of the panel”.**

Over and above any size or location restriction, making the SRM unworkable for anything but flat repairs.

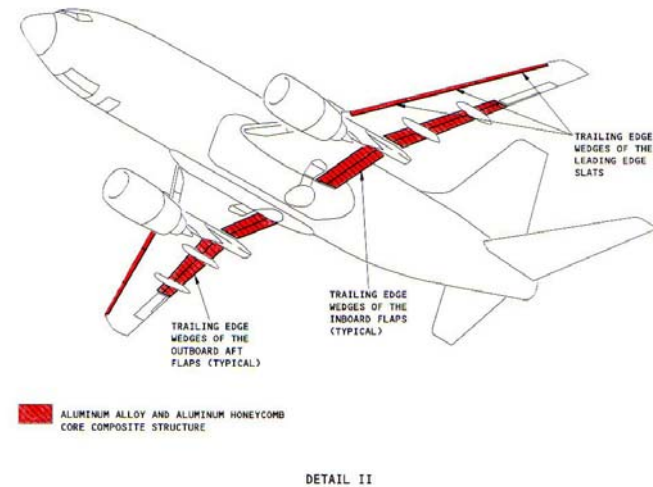
Legacy Airplane Model Applicability metal honeycomb structure

747-400

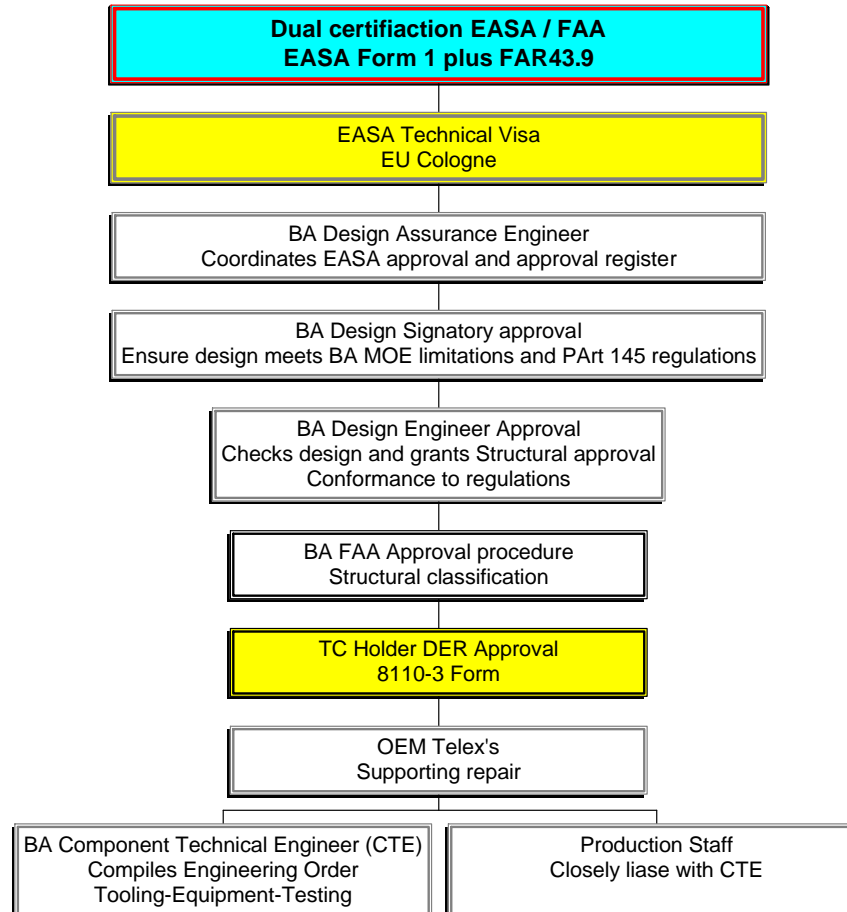


 BONDED ALUMINUM SKIN/HONEYCOMB SANDWICH

737-400



Approval process



Some Basic operational facts

Old SRM Process	Task	New SRM process	Basic time / cost Man-days
√	Part removal	√	1
√	Transport to LHR	X	3
√	Investigation	√	0.5
√	Engineering Order	X	2
√	Telex's	X	1
√	Internal Approval	X	1
√	FAA approval	X	3
√	EASA Approval	X	4
√	Part Installation	X	1.5
Ave 200 repairs per annum @ basic £50/hour 10 BA man-days £600K/annum excl repair cost			17 DAYS

Operational repairability of Metal bonded Structures

- No on wing preparatory process for permanent repairs.
- PANTA / PACS electrical transformers not approved in hangars
- Fluid entrapment risk – corrosion
- Health and Safety, issues with some processes
- Access and position and Environmental problems
- SRM limitations – size, location, process
- OEM inputs always reqd, same basic issues all the time
- Time constraints and component removal

'Out of scope' damage

B737 Outbd TE Foreflap



B737 Inbd TE Foreflap



‘Out of scope’ damage

B737 Outbd TE Aft flap

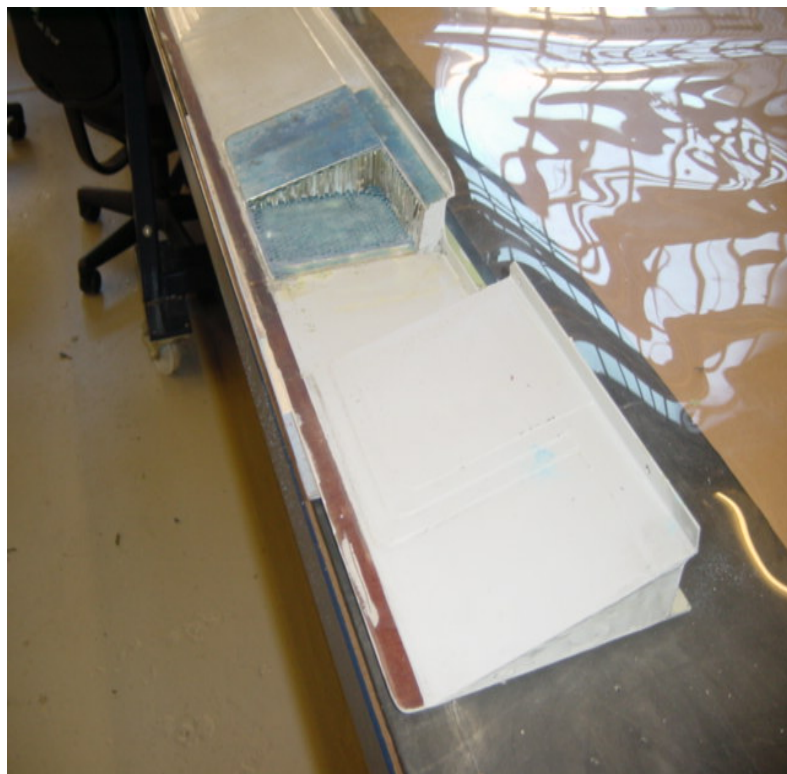


B737 Outbd TE Foreflap

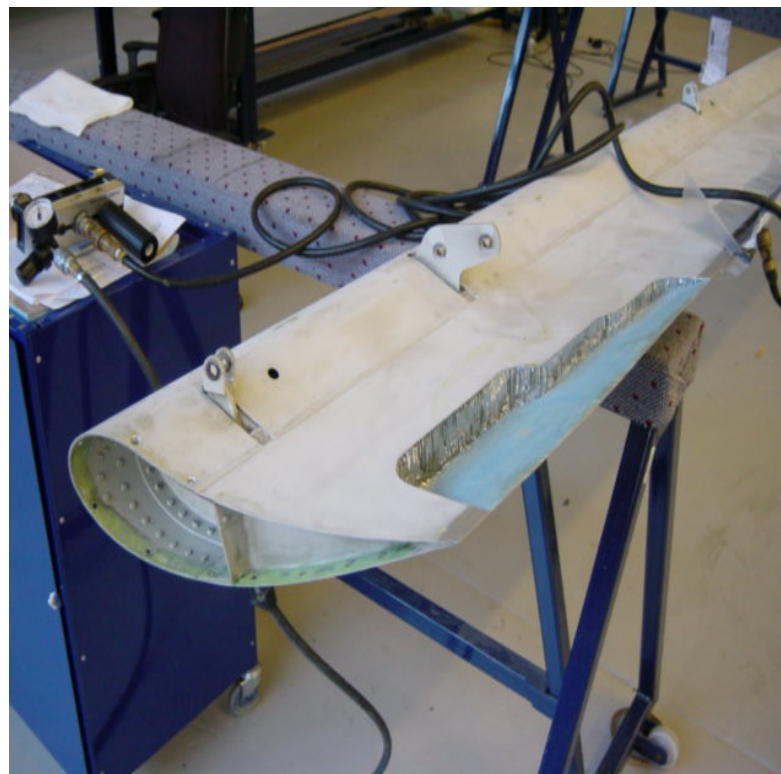


‘Out of scope’ damage

B737 Mid Flap cove



B737 Outbd Fore flap



SRM Task Group for metalbond development

- Set up Feb 2001
- British airways, United Airlines, Northwest Airlines, Delta and US Airways.
- Boeing 737, 767 FAA DER's
- Boeing BMT and service support specialists
- Boeing Customer service coordination

SRM Task Group for metalbond development

Goals

- Develop alternative process to HF etch
- Increase repair allowables to a realistic figure
- Introduce new methods, materials and processes
- Improve long term durability.
- Develop new SRM metalbond chapter
- Promote further operator input into SRM development
- Continuous communication between members
- Share knowledge freely

SRM Task Group for metalbond development

2 years



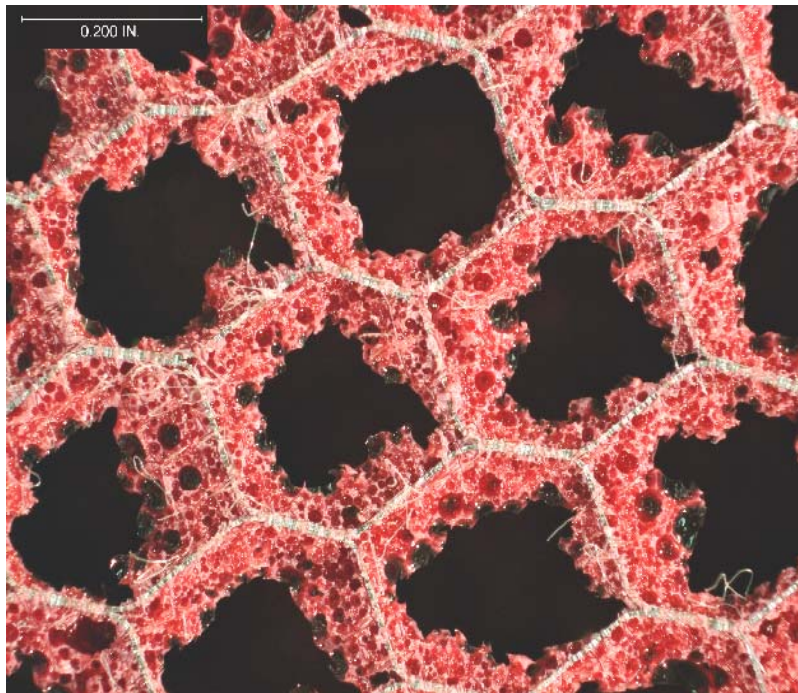
- Issues
- Bondline porosity
- One sided Filleting
- Unrealistic allowables
- Evacuation problems
- Consolidation
- Adhesive selections
- Surface preparation
- Skin core mismatch
- SRM introduction
- Durability

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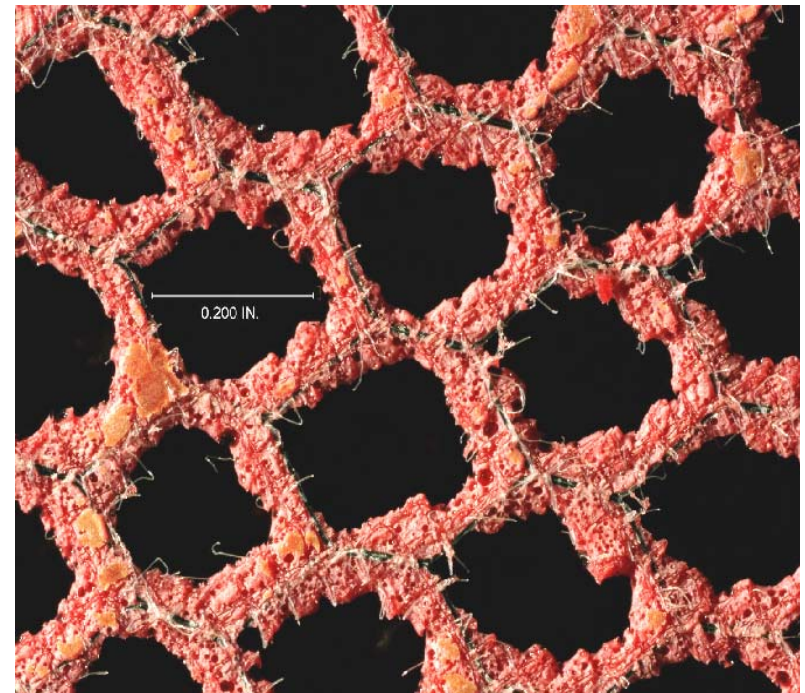
- Resolution
- New cure procedures
- New lay-up & cure procedures
- New RDL
- Control pre cure vacuum levels
- Verifilm and foil inspection
- Limit type from basic spec.
- Introduced Boegel AC130
- Define limits
- Operator Input and review
- Use PAA Core

Process Testing - porosity

2 plies Gd 10 Full vacuum 5F/Min

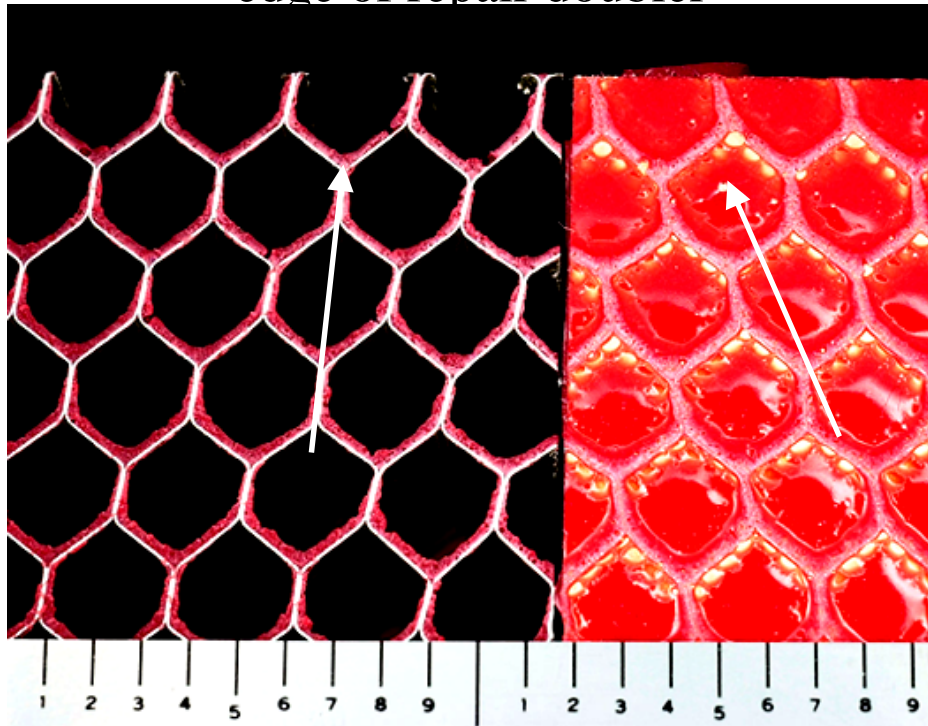


2 plies Gd 10 full Vacuum 1F/min



Process Testing – one side filleting

edge of repair doubler

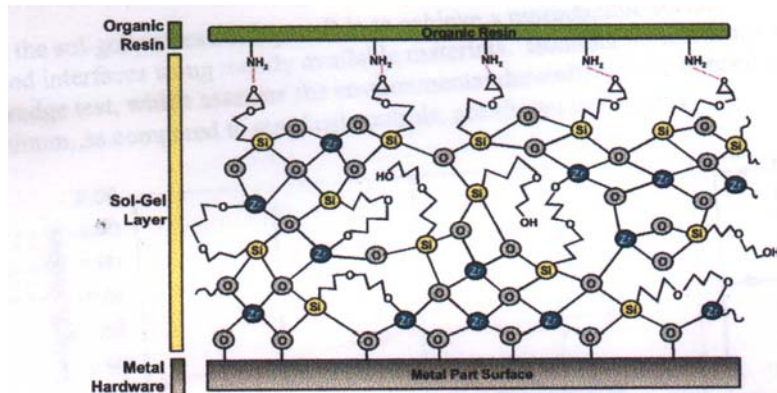


- Occurs on vacuum only
- Induced air entrapment to repair edge
- Reduced peel strength
- Fillet optimisation reqd

Resolution

- 2 plies grade 10
- Slow ramp rate 1-2F/min
- Use positioning fabric.

New Process Boegel AC130



- Sol-gel Technology
- Ideal for On wing application.
- Safe and Simple process
- High durability
- Inexpensive
- Quick
- No corrosion issues
- Kit form

New Process Boegel AC130 Certification testing

environmental exposure tests

- Wide area lap shear tests**
- Environmental exposure tests**
- Chemical exposure**
- High cycle fatigue and peel tests**
- Flatwise tension tests**
- Wedge crack extension**
- Double cantilever beam**
- Multiple operator sensitivity trials**

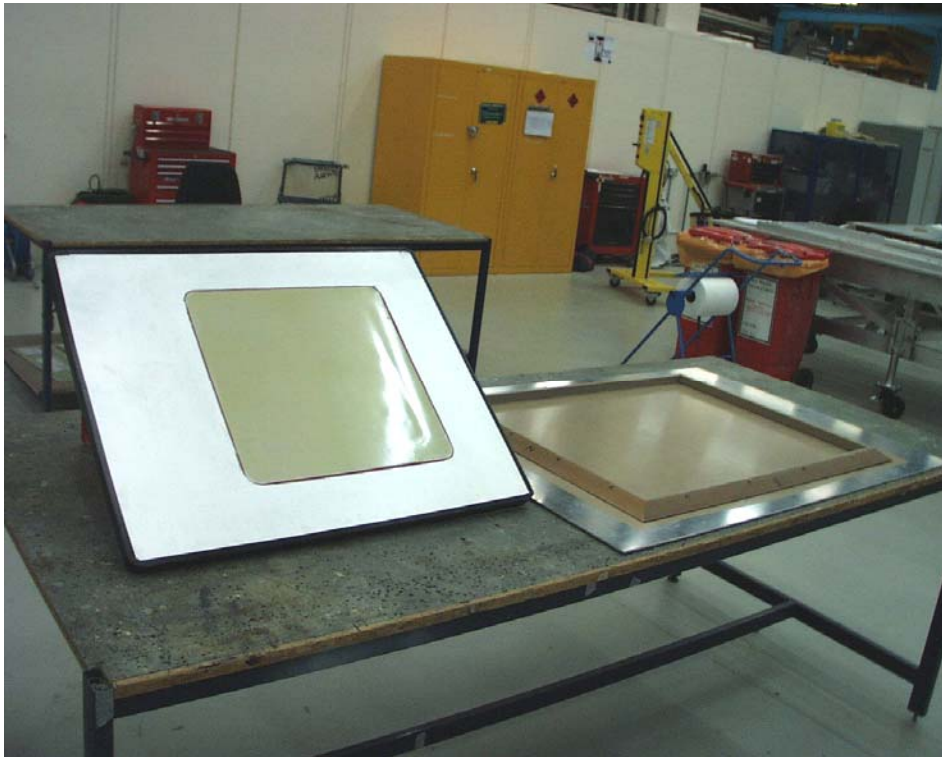
Comparative final results to PANTA anodise

New Process Boegel AC130

Human factors Issues

- Currently ONLY “Merit” ALO resin bond sanding pads are specified.
- Sanding techniques
- Process Time limits adherence
- Diligence
- Only water based Bond primer

200 sq inch Vacuum bond test panel.



- 14 X 14 inch cut out, 17 X 17 inch doubler
- PANTA anodise panel.
- Tank anodise doubler
- 2 films GD 10
- 1 inch thick core
- Positioning bleed fabric
- Vacuum only 2 stage 250F/90mins cure
- Ultrasonic NDT

Operators responsibility

- Report damage and repair trends
- Request repairs be included at next revision
- Create dialogue on new technologies and Environmental issues
- Report all errors, ambiguity and inconsistency
- Submit new practices and solutions
- Do not be apathetic – get involved
- Enhance safety and reduce cost at every level

Operators expectation of SRM's

- ✓ Planned Incorporation of frequently used repairs
- ✓ Justify arbitrary limitations or remove them
- ✓ Operational focus
- ✓ Circulate proposed amendments
- ✓ Invite operator inputs
- ✓ Keep open mind on new or alternative processes and methods
- ✓ Judicious use of test pieces

SRM Task Group for metalbond development Achievements

- ✓ New metalbond SRM with a read across into all Boeing models
- ✓ Expected Q4 2004
- ✓ New user friendly processes
- ✓ New consolidation Inspections
- ✓ Increased repair allowable to 200 sq inch
- ✓ Greater durability
- ✓ Standardised materials and procedures
- ✓ Optional Autoclave bonding
- ✓ No shape restrictions
- ✓ Reduced telex traffic by 90%
- ✓ Reduced need for Operator Engineering Orders
- ✓ Expected saving in Engineering support alone £420K/annum

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through SRM development**

Questions