IN FIELD BONDING METAL REPAIRS. EFFECTS OF SURFACE PREPARATION.

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Background of study

- Temporary structural repair on metals
- Quick repair, 6 hours maximum
- Simple surface preparation
- Use of RT curing adhesive
- No complex tooling or equipment

Materials and Test Method

- Material:
  - Al alloy 2024 T3 bare AMS-QQ-A-250/4, Chromic anodized and coated with polyurethane primer
  - Paste adhesive EA 9303.3 NA
- Test Method:
  - ASTM D 1002, room ambient condition
  - Non conditioned test specimens

Procedure

- Preparation of test samples
  - Surface preparation of samples under uncontrolled repair workshop condition
- Application of adhesive paste and cure
- Test of samples

Surface Preparation

1. Primer coated. Samples are not stripped and adhesive is placed on top of original protective coating of sample(Paint)
2. Primer coated. Samples are not stripped, but the coating is sanded using 180 grit (P180)
3. Stripping of primer and cleaning with solvent (MEK)

Surface Preparation (2)

4. Stripping of primer and sanding with 180 grit paper, solvent cleaning (L180)
5. Stripping of primer and sanding with 240 grit paper, solvent cleaning (L240)
6. Stripping of primer and application of chemical conversion coating (Alodine 1200)

Test Results

Surface Preparation	Lap Shear Strength (Mpa)	Adhesive Thickness (mm)	Failure Modes
MEK (3)	18,250	0,228	Mixture
L240 (5)	17,150	0,166	Cohesive
L180 (4)	15,650	0,308	Cohesive
P180 (2)	15,080	0,192	Cohesive
Alodine 1200 (6)	12,840	0,304	Adhesive
Paint (1)	8,980	0,118	Adhesive

Discussion of Results

- Shear strength baseline is 29 MPa. Regardless of the surface treatment the maximum shear strength obtained was only 60% of baseline at best.
- Best results are obtained when the surface is roughened, original primer is mechanically stripped, thus giving a roughened surface already.

Discussion of Results

- Mechanically roughened surface give better results but must be solvent cleaned to be effective.
- Thickness of adhesive can not be controlled without the aid of tooling.

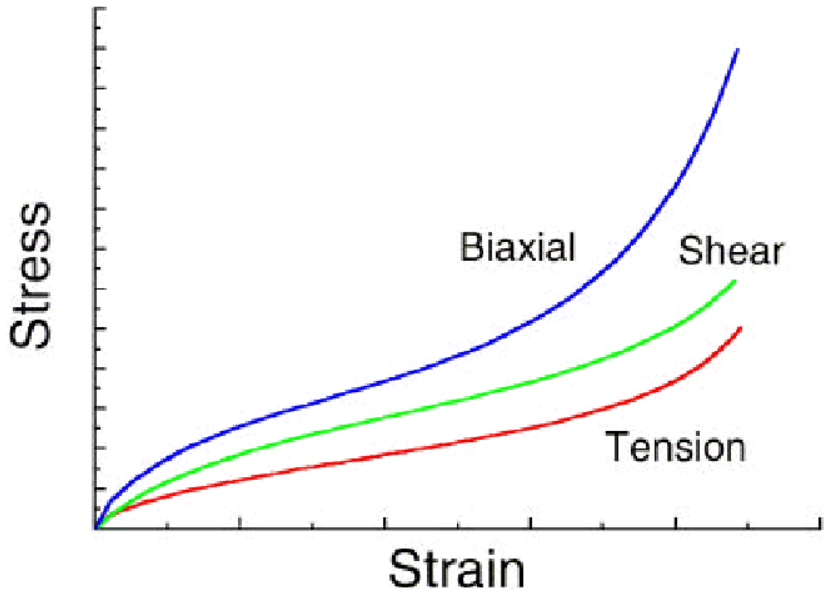
FEM Model

- MARC FEM model non linear analysis approach
- Elastomer curve based upon Ogden material type
  - The Ogden material model, describes the detailed mechanical behaviors of viscoplastic materials, in MARC brick elements.
  - Viscoplastic materials models provide reliable analysis results even after yielding
  - The Ogden material is more accurate in this range of deformation analysis.

FEM Model (cont.)

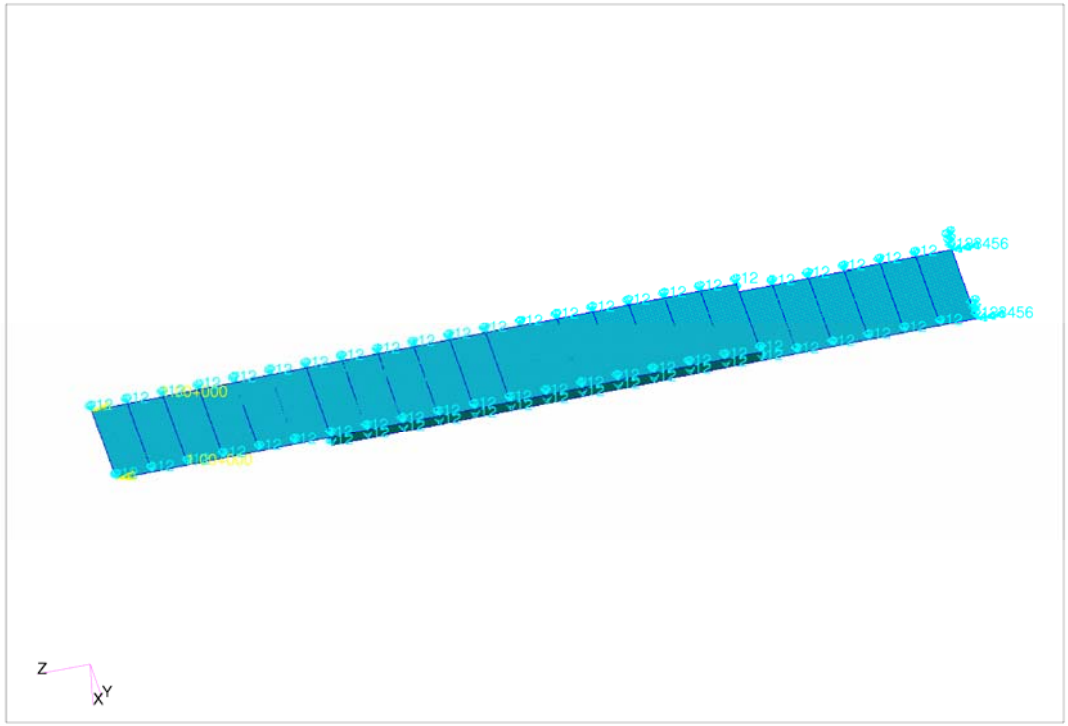
- Shear stress at bonded area obtained
- Non linear behaviour at different load levels behaviour characterisation

FEM Model cont´d

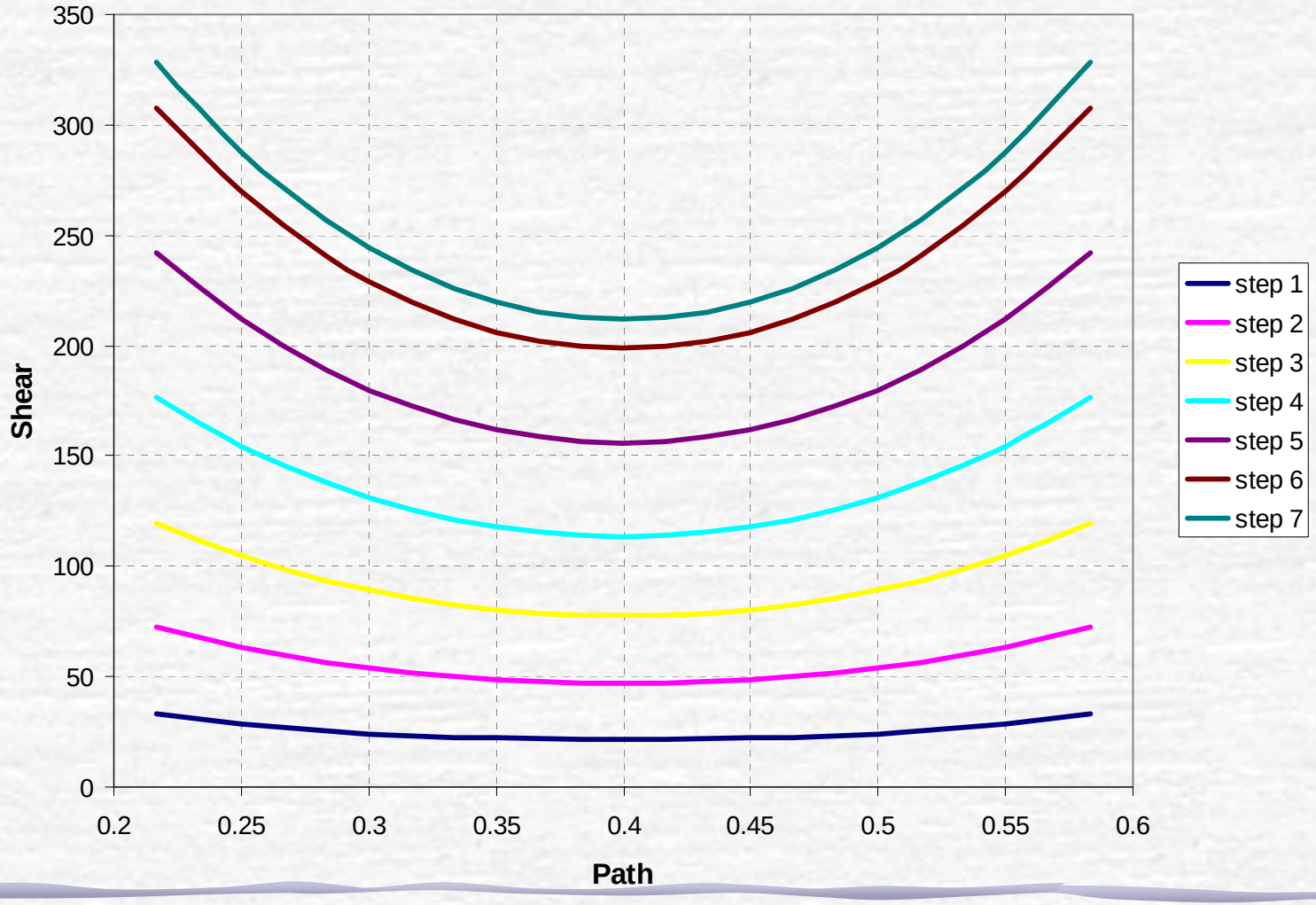


Typical generic stress-strain curve for adhesives

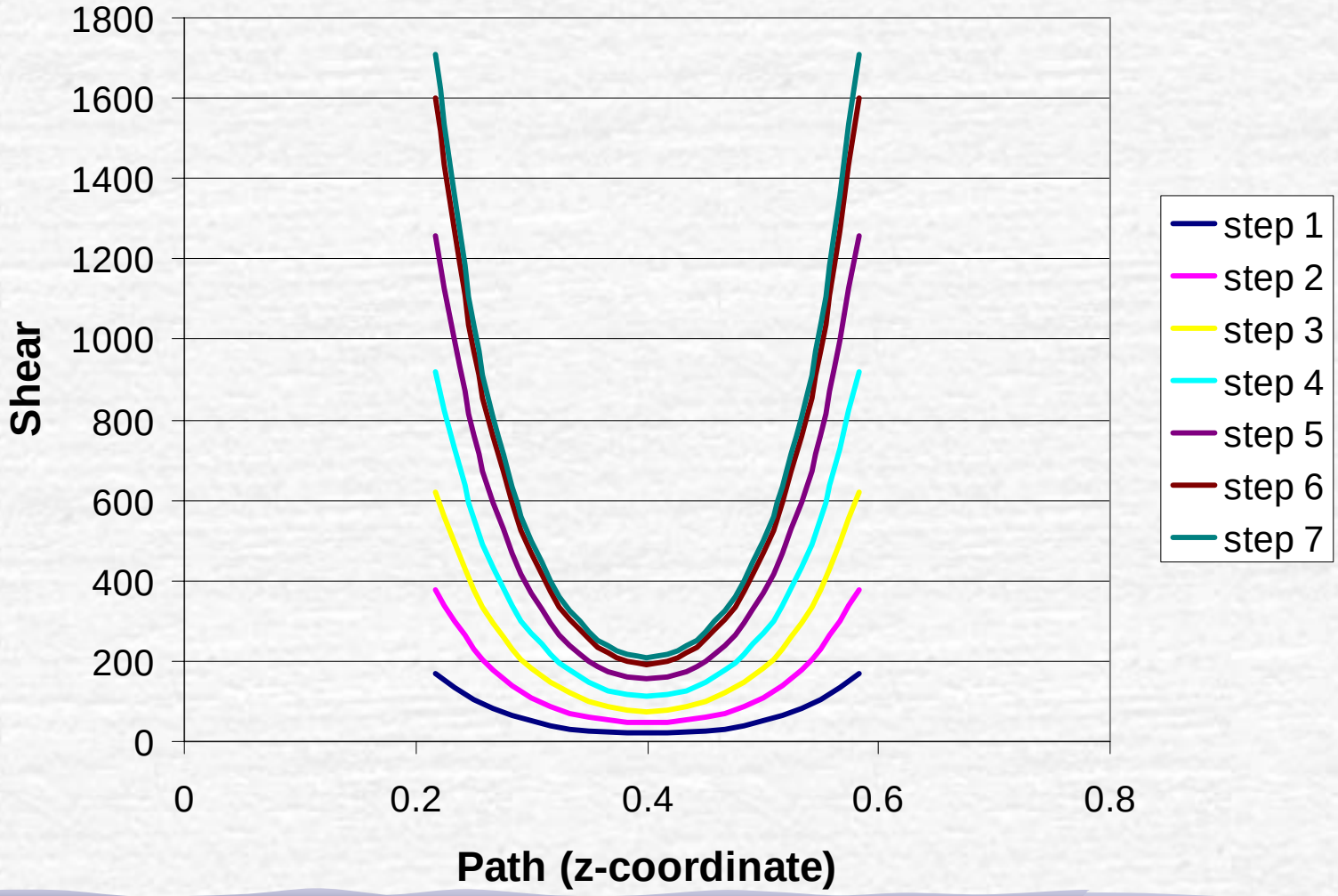
FEM Model cont´d



FEM Model cont´d



FEM Model cont´d



Conclusions

- Workshop environmental conditions must be controlled
- Surface preparation procedures must be clearly established and easily controlled
- Repair analysis must take into account the knock down effects of surface preparation effects