World-Class Competitiveness

Pin Load Control Applied to Retractable Pin Tool Technology

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Rocketdyne
Propulsion & Power
Pin Load Control

Agenda

• Acknowledgement, NASA/MSFC
• Retractable Pin Tool Development
  • Phase I, Proof-Of-Concept
  • Phase II, Pre-Production Article
  • Phase III, RPT w/ Pin Load Detection
• Retractable Pin Tool Calibration
• Phase III Tests and Evaluation Criteria
• Conclusions
Pin Load Control

Phase I, RPT Feasibility

Proof-Of-Concept

- Built in the Summer of 1996
- Key-Hole Close-Out First Demo Aug. 1996
- Results of Destructive Tests Very Promising
- Limitations
  - Only Configured for .25” Mat.
  - Manually Operated
  - Probe Placement Inaccurate
  - Fixture Clearance Minimal
Phase II, Pre-Production

Phase II
NASA Contract Sept 1997

- Two Programmable RPT Effort
- Configured for Material Thickness range .125 - .750
- Increased Fixture Clearance
- Incorporates Digital Gauge for Precise Probe Placement
- Key-Hole Elimination Demo Jan 1998
- Tapered Thickness Joining Demo Feb 1998

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MECHANICAL OPERATION

- Totally Portable, Plug and Play Device

Main Features

- Drive Assembly
- Drive Shaft Assembly
- Main Housing
- Specially Designed Rotary/Linear Slide
- Separated Two Z Axes of Motion
- Rotary Axis
- Couples Probe and Shoulder

Peripheral Components
Phase III, Pin Load Detecting Integration

OBJECTIVE:
- Demonstrate Pin Placement Accuracy
- Test a Pin Load Detecting System

LOAD DIAGRAM
Phase III RPT Calibration

Pin Tool Model

Rpt Pin Length Calibration

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Test Parameters and Evaluation Criteria

Tests

- Constant Pin Length/Constant Material Thickness
- Varied Pin Length/Constant Material Thickness
- Varied Pin length/Tapered Material Thickness
- Exit Hole Elimination/Constant Material Thickness

Material: 2219 and 2195

Panel Thickness Mapped Prior to Welding

RPT Pin Length Measured Before and After Welding

Data Collected: Pin Shear Load, Pin Axial Load, Total Axial Load, and Pin length

Data Plotted: Welding Time Verses Load

Weld Parameters

- Pin Diameter: .375" Diameter Pin, 3/4 X 24 LH Thread
- Shoulder Diameter: .938" Diameter
- Plunge Speed: .100"/min
- Lead Angle: 2.5 Degrees
- Welding Speed: 2.5 and 3.5"/min
- Shoulder Material Depth: .008"

Evaluation Criteria

- Visual
- Metallurgical Cross-Sections
- Event verses Load
Constant Pin Length/Constant Material Thickness

PIN LOAD DATA

Transverse Section
Pin Lg: .308, Mat Th: .319

Transverse Section
Pin Lg: .318, Mat Th: .320

Transverse Section
Pin Lg: .328, Mat Th: .322

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Varied Pin Length/Constant Material Thickness

PIN LOAD DATA

Test Pin: 5
Weld Speed: 2.5' / min
RPM: 225
Material: 2195
Mat thickness: .318" to .320"
Shoulde Depth: .008"

Transverse Section
Zone 1
Transverse Section
Zone 3
Transverse Section
Zone 5

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BOEING NASA
Varied Pin Length/Constant Material Thickness

PIN LOAD DATA

Test Ptn: 9
Weld Speed: 2.5"/min
RPM: 225
Material: 2219
Mat Thickness: .317 Average
Shoulder Depth: .008"

Total Axial Load
Pin Axial Load
Pin Shear Load

ELAPSE TIME, MINUTES / SECONDS
FORCE, POUNDS
PIN LENGTH, INCHES

Transverse Section
Zone 1
Zone 3
Zone 6

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Varied Pin Length/Constant Material Thickness

Pin Load Control

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Varied Pin Length/Tapered Material Thickness

PIN LOAD DATA

ELASPE TIME, MINUTES / SECONDS

FORCE POUNDS

PIN LENGTH, INCHES

TOTAL AXIAL LOAD

PIN LENGTH

PIN AXIAL LOAD

PIN SHEAR LOAD

E - 3.00" Transverse Sections

7.50" Transverse Section

12.00" Transverse Section

Taper Pnl 1 & Taper Pnl 2 Load Comparison

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Exit Hole Elimination/Constant Material Thickness

PIN LOAD DATA
EXIT HOLE CLOSE-OUT

Test Pin: Exit Hole Elimination 1
Exit Speed: 3.0 in/min
Material: 2219
Min. Thickness: 0.15 to 0.17 in
 Pin Retract Rate: 2265 in/min
Shoulder Depth: 0.08 in
Pin Length: 0.032 in
Pin to Axle Dist.: 0.05 in

EHE Demo 1

Transverse Section

Zone 5

Transverse Section

Zone 6

Transverse Section

Zone 7

Transverse Section

Zone 8

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Exit Hole Elimination/Constant Material Thickness

Transverse Section

Zone 5

Transverse Section

Zone 6

Transverse Section

Zone 7

Transverse Section

Zone 8
Conclusions

- Demonstrated Pin Placement Accuracy
- Load Value Delta Between Total Axial Load and Pin Axial Load During Plunging versus Similar Load Profiles
  - Calibration Error
  - Electronic Noise
  - Bent RPT Components
- Recorder Pin Axial Loads are Believed to be High
- Greater Pin Depth - Higher Pin Axial Load
  - Pin Diameter
  - Number of threads in substrate
  - Alloy
- Higher Travel Speeds - Higher Pin Axial Load
- Incremental Pin Extension Produces Pin Axial Load Response Then Decays
- Welding Thick to Thin Taper Panels Produces Decreasing Pin Axial and Pin Shear Loads
- Welding Thin to Thick Taper Panels Produces Increasing Pin Axial and Pin Shear Loads

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