Grid to Tracker Stud Interface Trade Study

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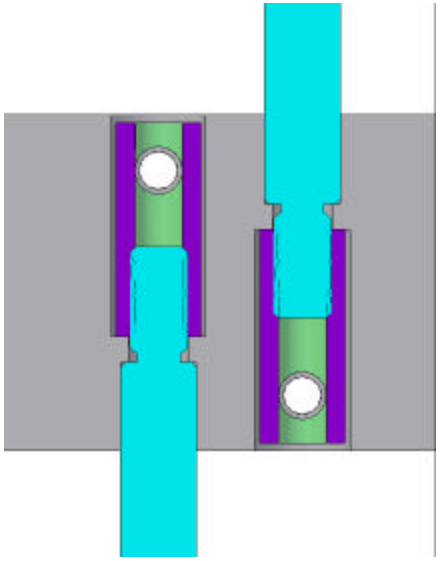
Rear Insert



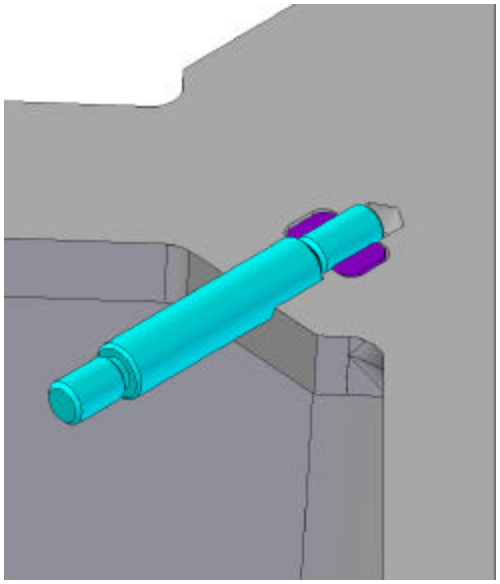
Pro's

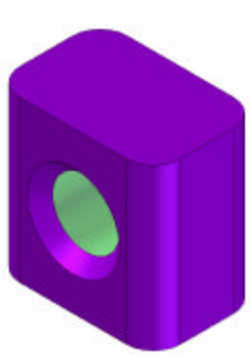
- No concentricity issues – wide range of float possible
- Serviceable at side flexure locations
- Eliminates grid stresses caused by bushing press fit
- Reduced tolerance requirements

Con's

- Not applicable to corner flexures
- Requires constraint to retain insert in cavity and prevent insert rotation
- Creates four openings on each mid-side location, causing larger pin stresses

Square Nut





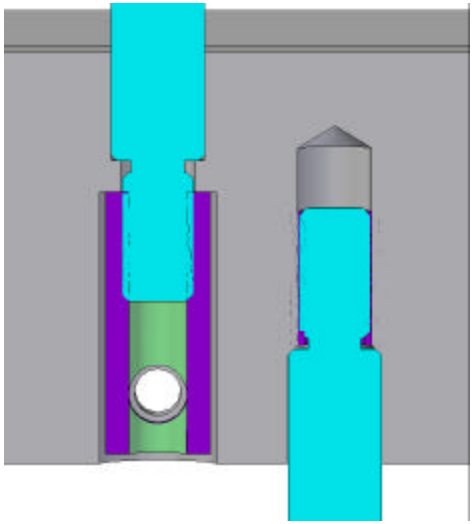
Pro's

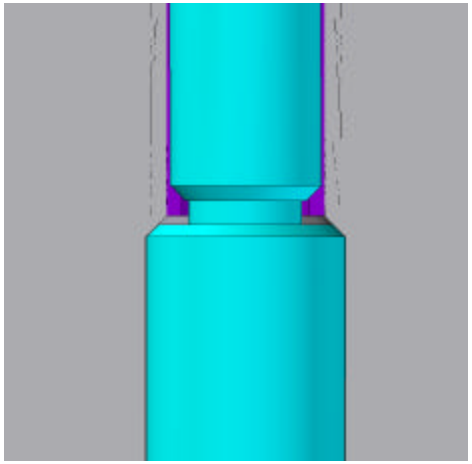
- No concentricity issues – wide range of float possible
- Serviceable at corner flexure locations
- Eliminates grid stresses caused by bushing press fit
- Reduced tolerance requirements

Con's

- Not serviceable at side flexure locations
- Requires shield from heatpipe bonding epoxy
- Requires constraint to retain insert in cavity and prevent insert rotation
- Creates four openings on each mid-side location, may increase stresses

Helicoil





Pro's

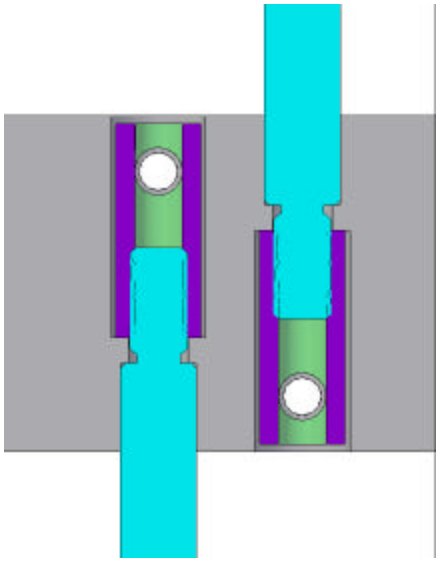
- Simplest design
- Lowest cost design
- Applicable at both side and corner locations
- Eliminates grid stresses from the bushing press fit

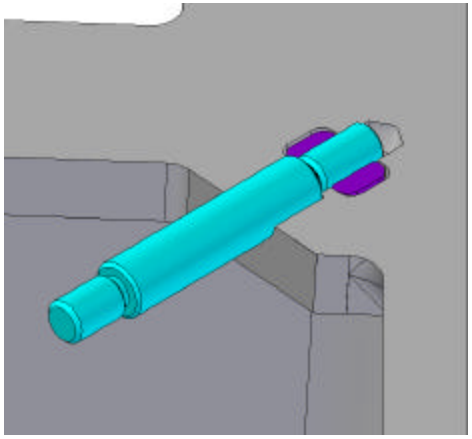
Con's

- Helicoils are intended for secondary structure not primary structure
- May spin out during disassembly or during vibration environment
- Not readily repairable
- May not meet concentricity requirements
- Stud would seat on chamfer

Recommendation

Square Nut at Corners & Rear Insert at Sides





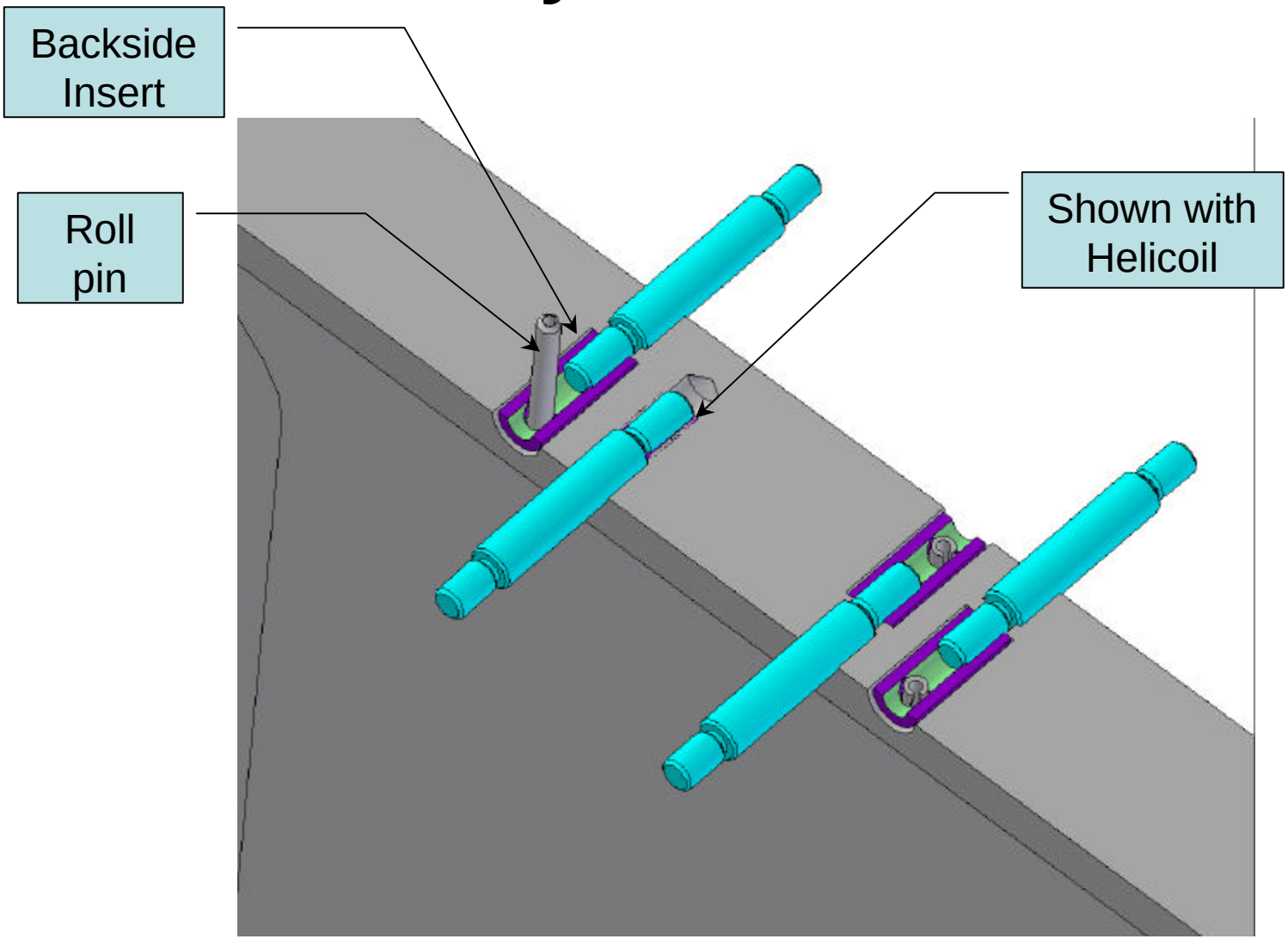
Pro's

- No concentricity issues
- Serviceable at all locations
- Eliminates grid stresses from the bushing press fit
- Same stud design & load path for dula ecentric design

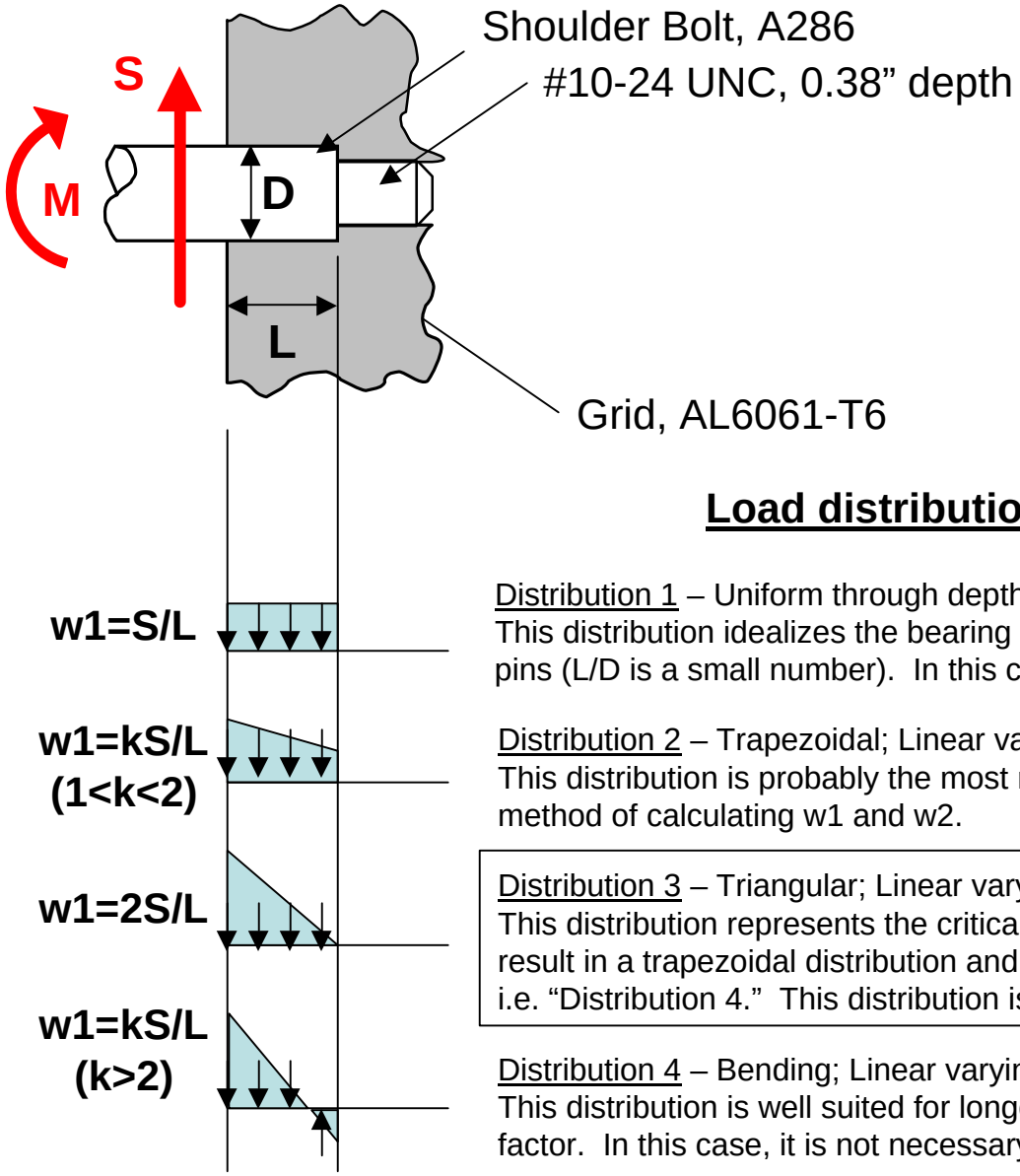
Con's

- Constraint required to hold insert and square nut in position
- Additional Stress Analysis Required

Cut-Away at Side Locations



Shoulder Bolt Bearing Calculation Assumptions



AL6061-T6 Bearing Strength
(e/D = 1.5): Fby = 53 ksi; Fbu = 69 ksi
(e/D = 2.0): Fby = 61 ksi; Fbu = 90 ksi

Smax = 811 lbf = 3.61kN
M = 0 N-m
L = 0.279 in = 7.09 mm
D = 1/4 in = 6.35 mm

Load distributions considered

Distribution 1 – Uniform through depth – UNCONSERVATIVE.
This distribution idealizes the bearing load of the pin on the hole, but is valid for short pins (L/D is a small number). In this case, L/D is 0.89, which is not small.

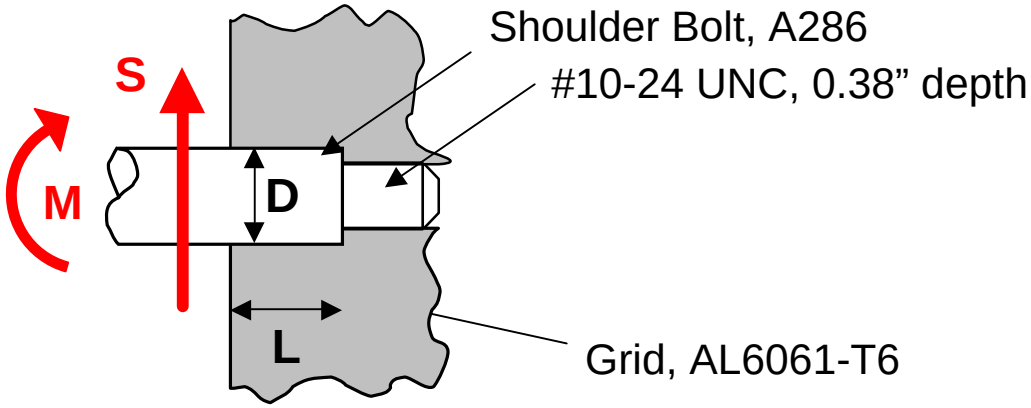
Distribution 2 – Trapezoidal; Linear varying through depth – REALISTIC.
This distribution is probably the most realistic case. However, there is not a clear method of calculating w1 and w2.

Selected Method

Distribution 3 – Triangular; Linear varying through depth – CONSERVATIVE.
This distribution represents the critical pin depth where less engagement would result in a trapezoidal distribution and more engagement would result in pin bending, i.e. "Distribution 4." This distribution is conservative and easy to calculate.

Distribution 4 – Bending; Linear varying through depth – MOST CONSERVATIVE.
This distribution is well suited for longer pins where pin bending may become a factor. In this case, it is not necessary to be overly conservative.

Shoulder Bolt Bearing Calculation Margins



AL6061-T6 Bearing Strength
(e/D = 1.5): Fby = 365 MPa; Fbu = 476 MPa
(e/D = 2.0): Fby = 421 MPa; Fbu = 621 MPa

Smax = 811 lbf = 3.61kN
M = 0 N-m
L = 0.279 in = 7.09 mm
D = 1/4 in = 6.35 mm

Bearing Stress in Alum Grid Using Load Distribution 3

Pin engagement into Grid is

L = 7.09 mm (0.279 in)
D = 6.35 mm (1/4 in)

Bearing load using load distribution 3

$$w_1 = \frac{2 \cdot S}{L} = 1.018 \frac{kN}{mm}$$

Bearing Stress calculation

$$s_{br} = \frac{w_1}{D} = 160 MPa \longrightarrow$$

MS_u = 1.13
MS_y = 0.83

Margins using Shear out-bearing strength from Bruhn (more realistic; based on empirical data)

Calculate Edge distance (e/D)

e = 7.493 mm (0.295 in); D = 6.35 mm (1/4 in)
e/D = 1.18

$$P_{Bru} = K_{Bru} F_{tu} A_{Br}; P_{Bry} = K_{Bry} F_{ty} A_{Br}$$

$$K_{Bru} = 1.2; K_{Bry} = 1.1$$

$$F_{tu} = 296 MPa; F_{ty} = 262 MPa$$

AL6061-T6
Ftu=296MPa
Fty=262MPa

$$A_{Br} = (7.09mm)(6.35mm) = 45.02 \cdot 10^{-6} mm^2$$

$$P_{Bru} = (1.2)(296MPa)(45.02 \cdot 10^{-6} mm^2) = 15991N$$

$$P_{Bry} = (1.1)(262MPa)(45.02 \cdot 10^{-6} mm^2) = 12975N$$

Adjusted Margin calculation $\longrightarrow$

MS_u = 2.16
MS_y = 1.88