Recent Developments for Conformal Contacts with Friction

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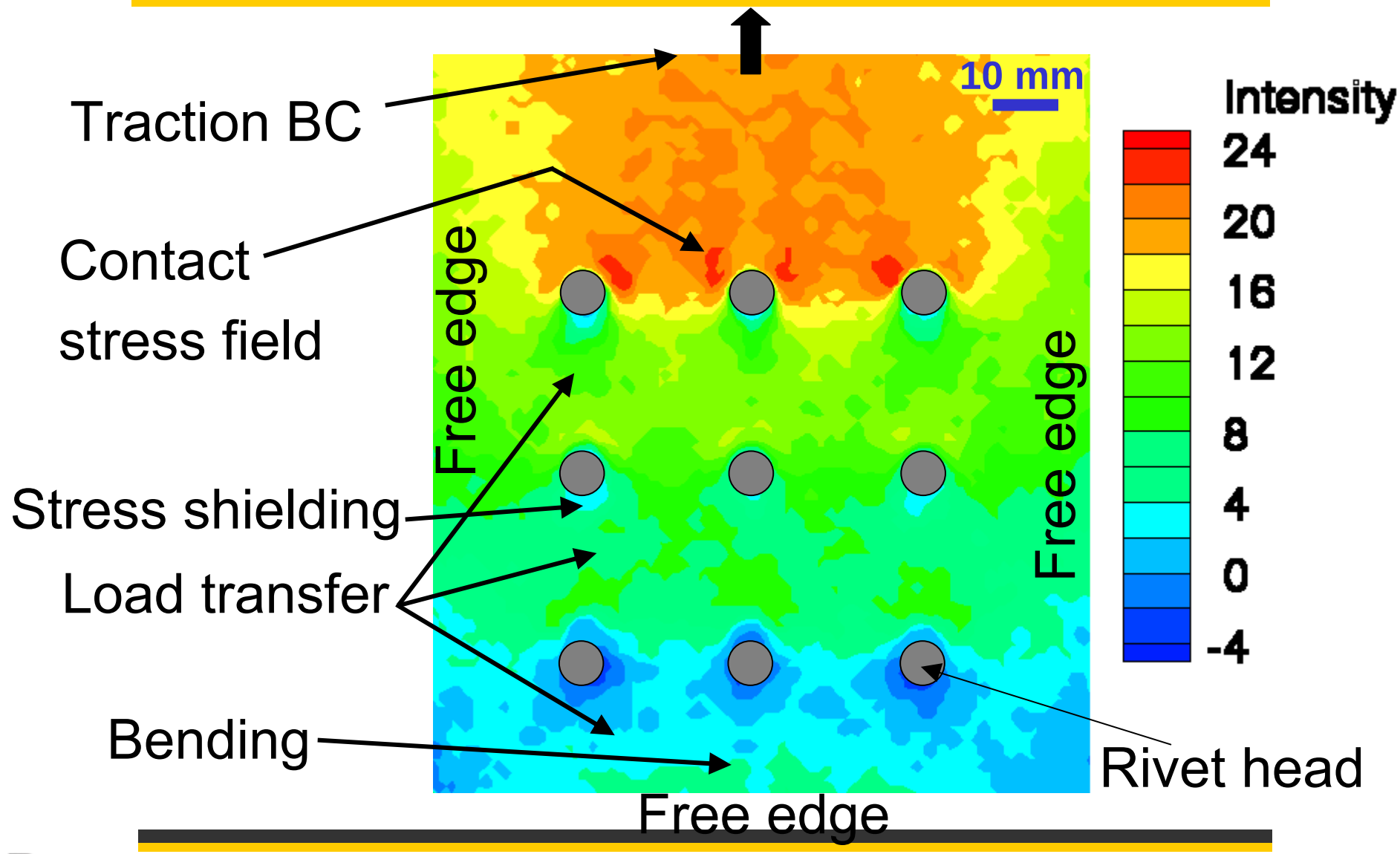
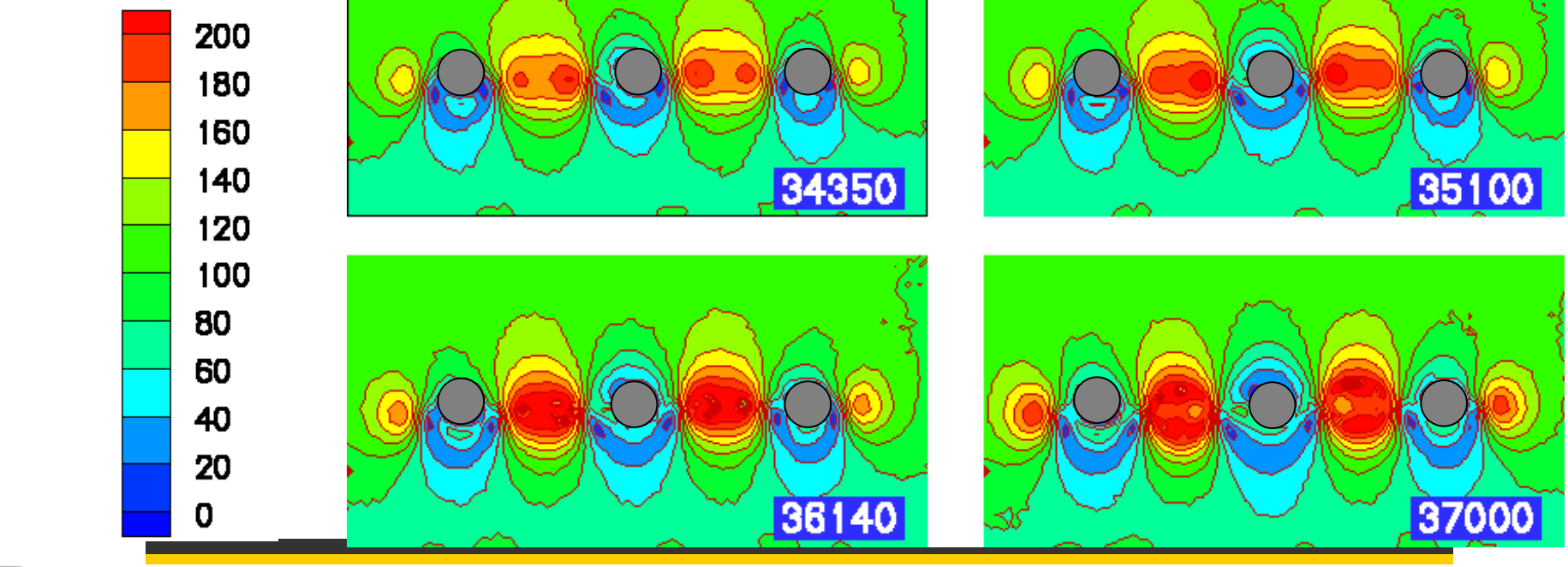
Applications (σ_o =110 MPa)



Crack Evolution

σ_o = 110 MPa

cycles to failure = 37500



Rigid-on-iso, Full Sliding

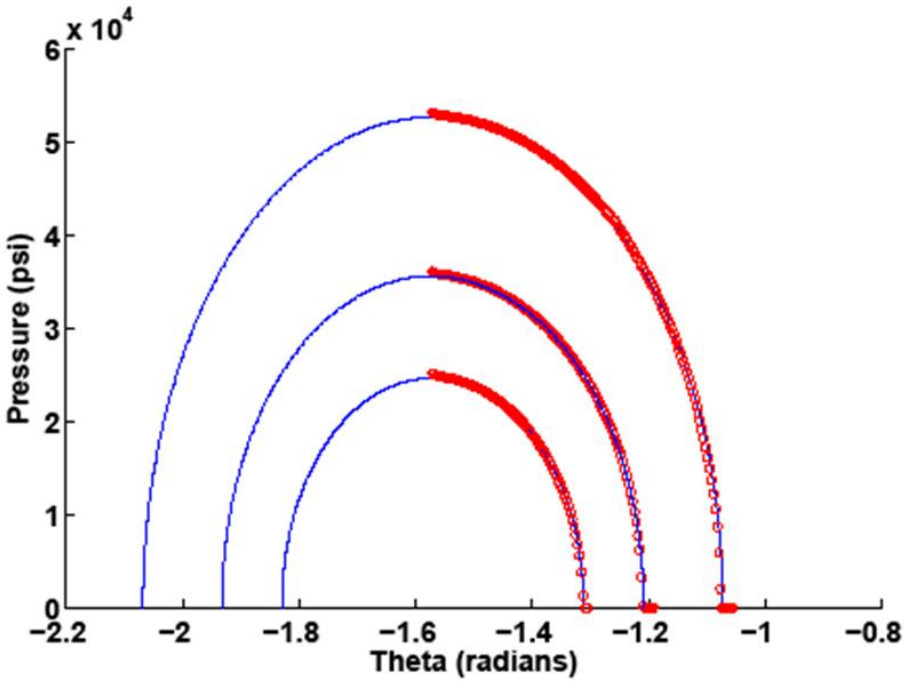
- Full sliding SIDE obtained from the coupled system derived earlier Solution scheme: Transform Hilbert kernel to Cauchy kernel, solve with Gauss-Chebyshev quadrature and Newton-Raphson search.
- Full sliding solution is interpreted as being caused by applied CW / CCW moments under the prevailing P,Q, remote stress conditions
- The moments inducing sliding are obtained as part of the solution

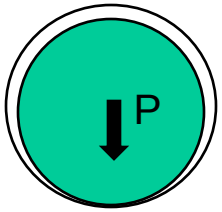
$$k'' = \kappa - 1 \qquad k' = \frac{\kappa+1}{2} \qquad \mathscr{A} = \sigma_{xx}^{\infty} + \sigma_{yy}^{\infty} \qquad \mathscr{D} = \sigma_{xx}^{\infty} - \sigma_{yy}^{\infty}$$

$$\begin{aligned} -R + R_D - \frac{Rk'}{2G}\left[\frac{A}{2} - 3D\cos(2\theta)\right] = \frac{R}{4\pi G}\Bigg[& k'\int_{\alpha}^{\beta} N(\xi)d\xi + 2\kappa\int_{\alpha}^{\beta}\cos(\theta-\xi)N(\xi)d\xi \\ & -k'\int_{\alpha}^{\beta}\cot\left(\frac{\theta-\xi}{2}\right)N'(\xi)d\xi - \pi k''N(\theta) \pm \mu k'\int_{\alpha}^{\beta}\cot\left(\frac{\theta-\xi}{2}\right)N(\xi)d\xi \\ & \mp\mu 2\kappa\int_{\alpha}^{\beta}\sin(\theta-\xi)N(\xi)d\xi \mp \pi k''\mu N'(\theta) \quad \forall\theta\in(\alpha,\beta)\Bigg] \end{aligned}$$

PIN LOAD ONLY

- Conformal contacts μ = 0
- R = 1.0” Rd = 0.99”
- E = 1.708 x 10^7 ν = 0.316
- Plane strain, κ = 1.735
- P = 10k,20k, 40k
- Solution of Singular Integro-Differential Equation using modified Gauss-Chebyshev method
- Solid line (SIDE), Marker (FEM)





REMOTE STRESSES + PIN LOAD

R = 1.0”

Rd =0.98”

κ = 1.735

P = 30k

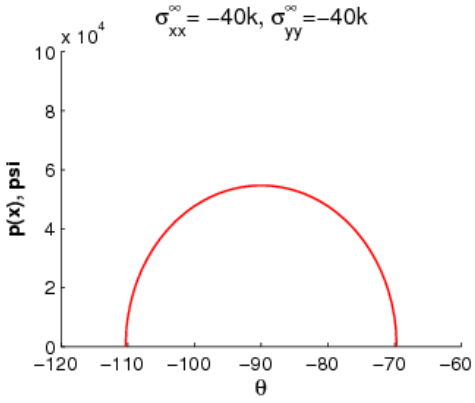
(all cases)

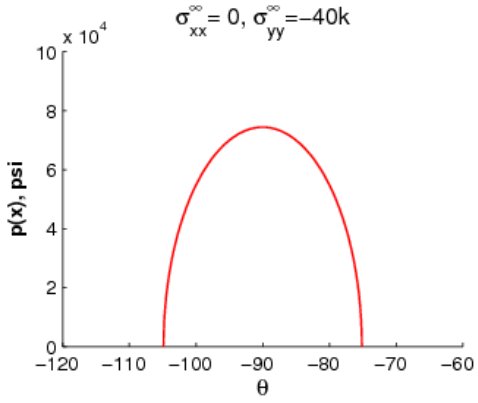
σ_{xx} =

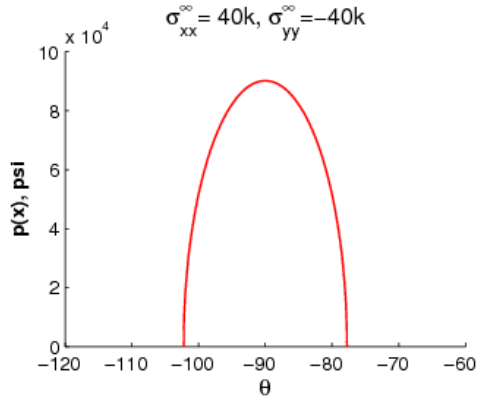
-40,0,40 ksi

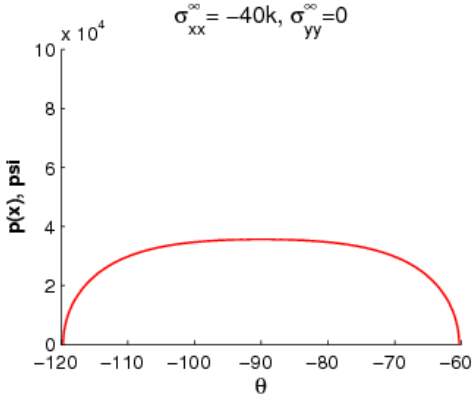
σ_{yy} =

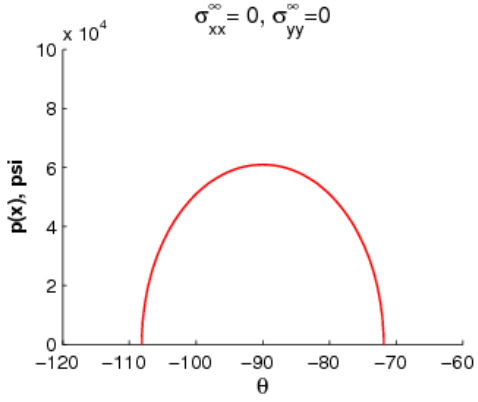
-40,0,40 ksi

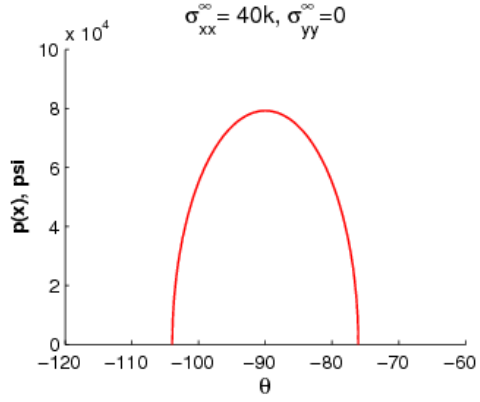


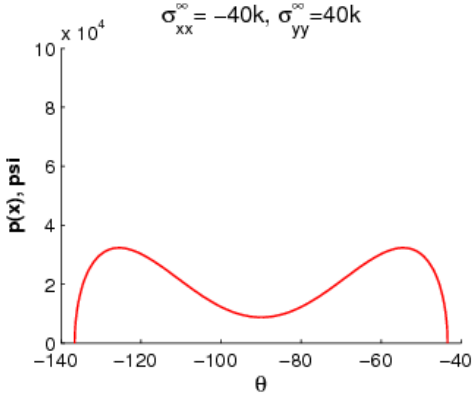


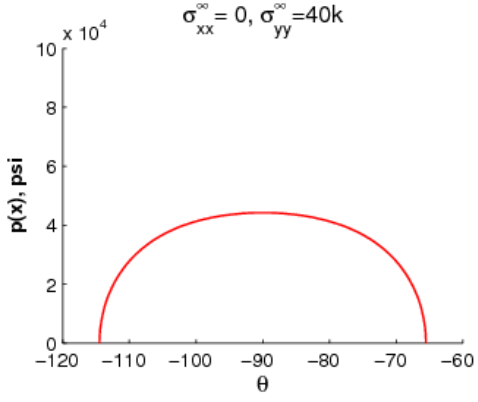


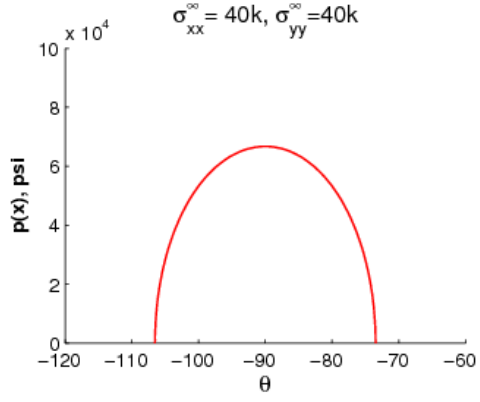












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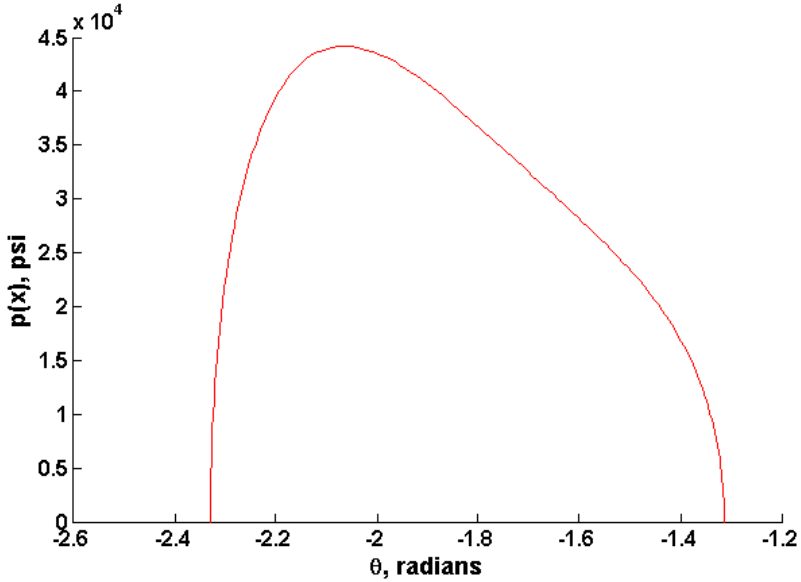
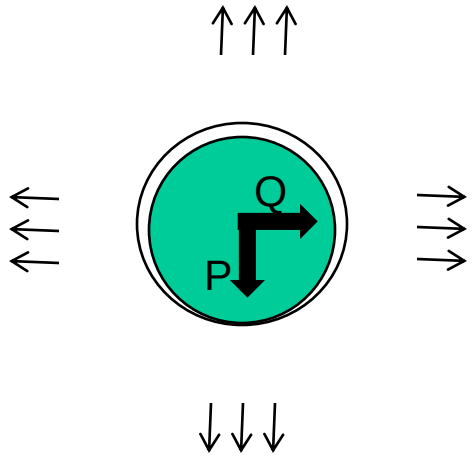
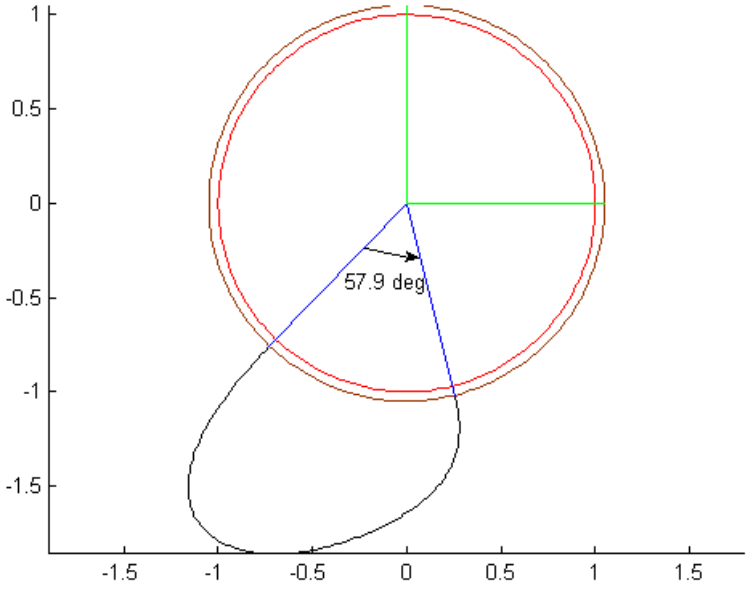
Oblique pin load+remote stresses

- Equivalent to P only + additional σ_{xy} at infinity when $\mu = 0$
- Essential to include Q in formulation because in presence of friction this is not possible without loss of generality
- $\kappa = 1.735$ R=1”, Rd=0.98”, P=30k, Q=-10k σ_{xx} = -10ksi, σ_{yy} = 50 ksi

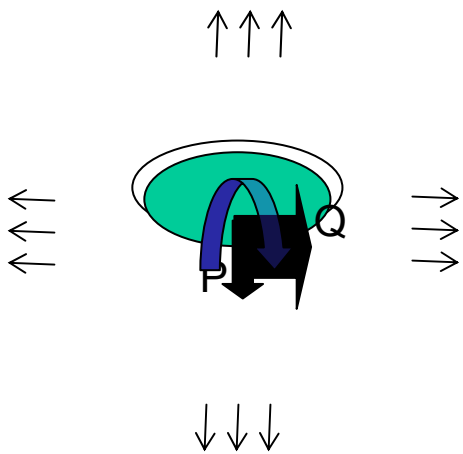


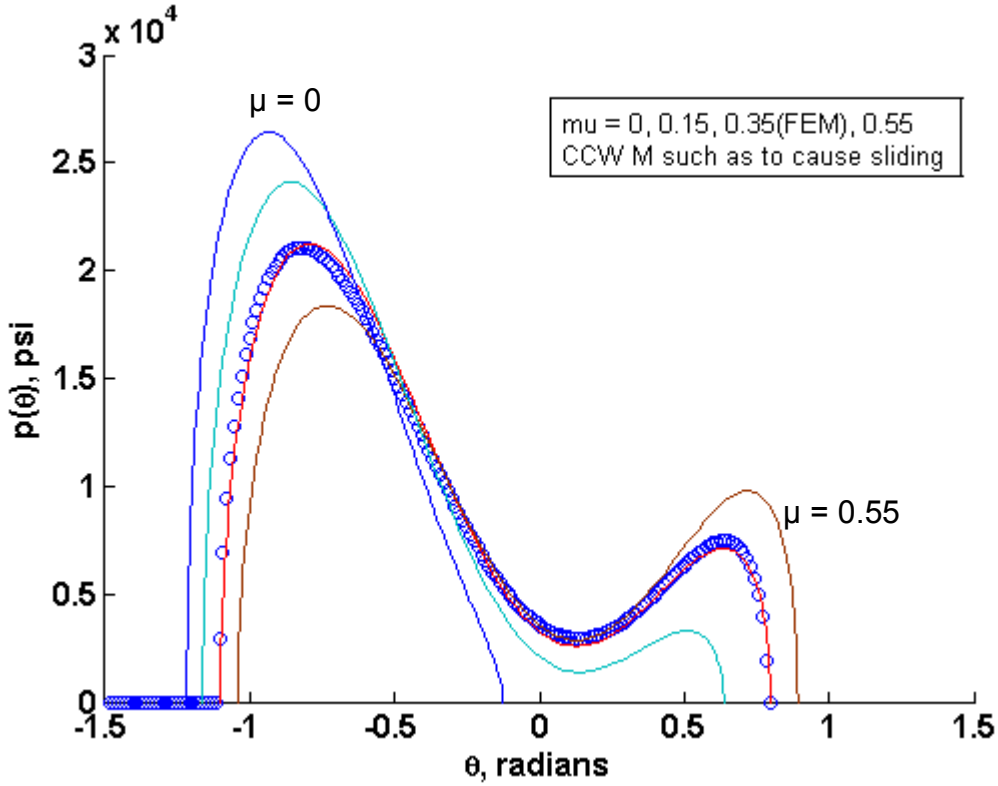




Generalized case of bulk-sliding

- μ = 0.0, 0.15, 0.35, 0.55
- R = 1.0” Rd = 0.995”
- E = 17.08 x 10^6 ν = 0.316
- Plane strain, $\kappa = 1.735$
- P = 12.5k, Q=12.5k
- σ_{xx} = -12 ksi, σ_{yy} = 12 ksi
- Solid lines (SIDE), Marker (FEM, very near sliding)

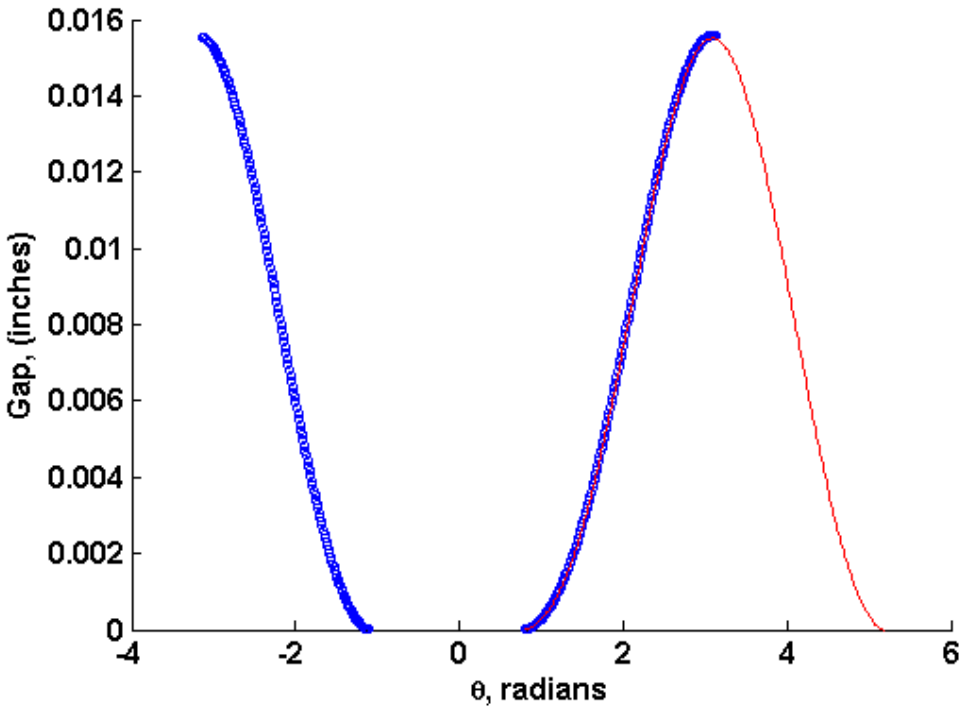




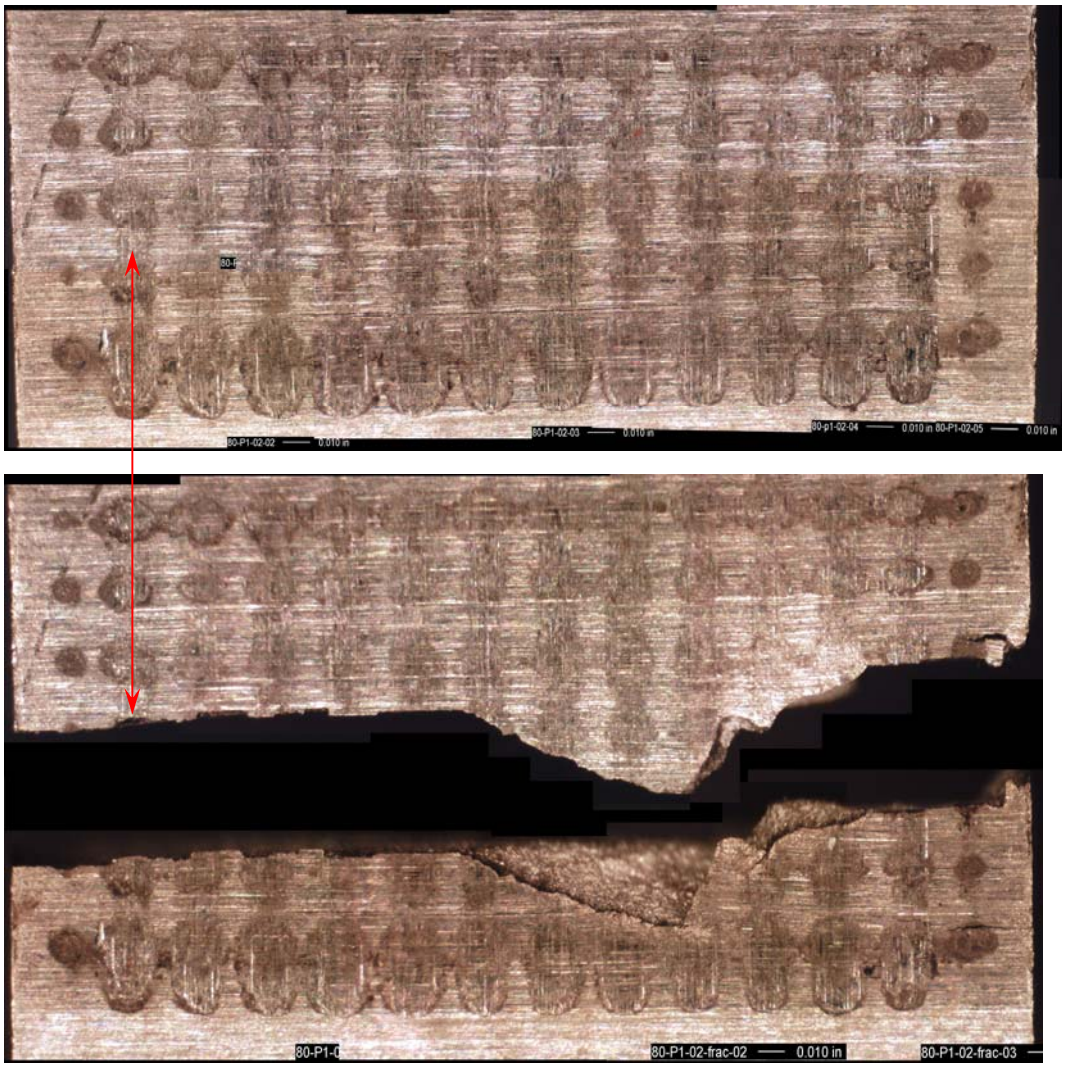
Results: Gap and approach for a full sliding problem

- Problem same as discussed before: has P,Q, stresses
- mu = 0.35
- Solid line SIDE + 2pt. bvp gap
- Markers FEM
- Points separated by 2*pi are identical
- SIDE predicted sliding moment M_{cr} = -6608, FEM ~ -6635

- **Previous results due to Persson and Ciavarella and Decuzzi**



LSP Contact Surface



- Top picture is prior to testing
- Bottom picture indicates fracture along middle of contact
- Arrow indicates origin of fatigue crack