Development of HTS Conductor on Round Core (CORC) cables for fusion applications at Advanced Conductor Technologies

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Improving CORC cable flexibility for accelerators

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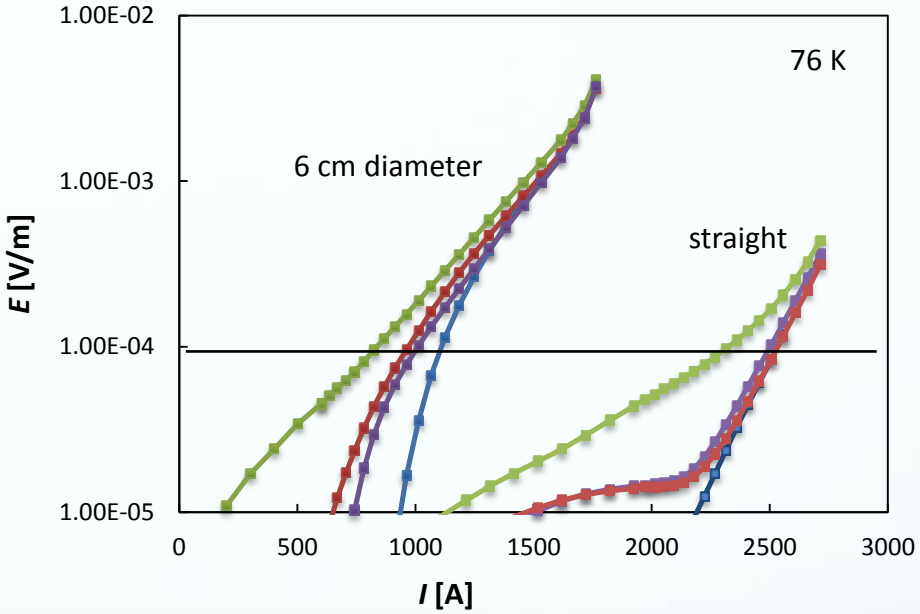
Cable:
26 YBCO CC, 11 layers, cable O.D. 6.0 mm

Straight: **I_c = 2425 A @ 76 K**

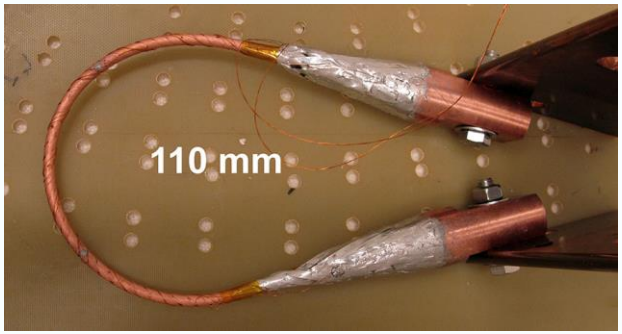


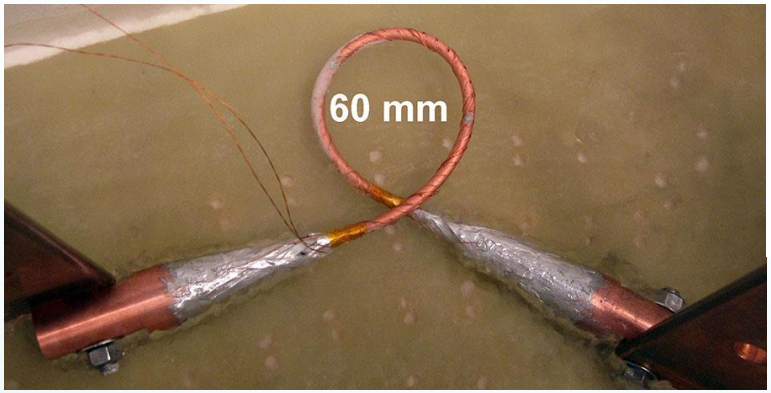
6 cm diameter: **I_c = 1057 A @ 76 K**

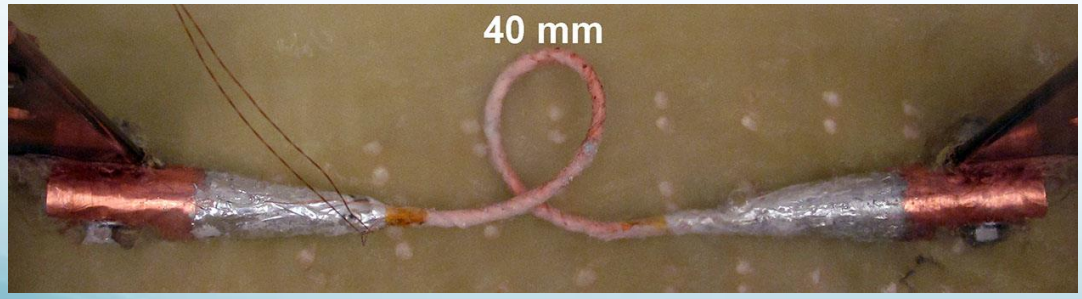
I_c = 1264 A @ 4.2 K, 19 T
J_e= 29 A/mm^2

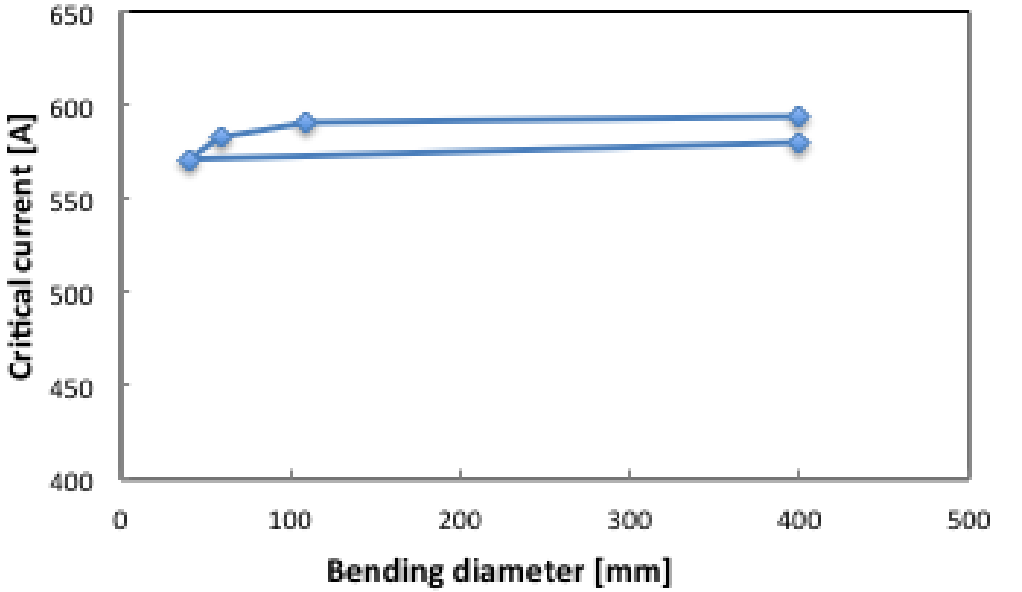
Large degradation of 56 % due to bending!

Improved CORC cable flexibility





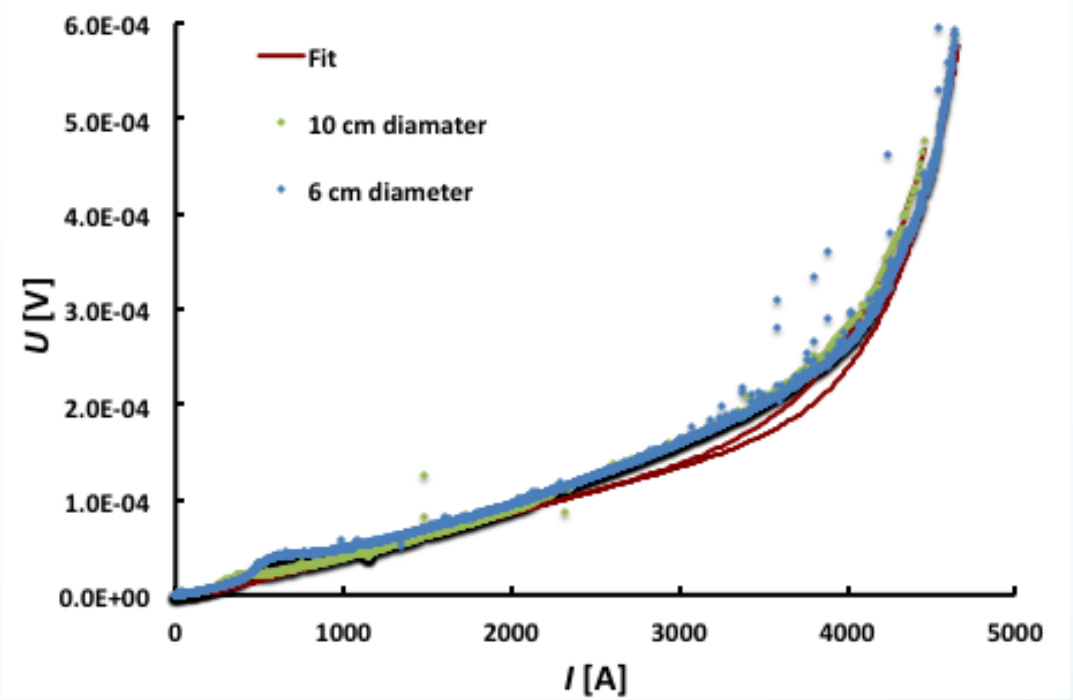




Irreversible degradation of only 2.5 % due to bending to 40 mm diameter!

CORC J_e>100 A/mm^2 at 20 T and 6 cm diameter

Cable:
- 37 YBCO CC, 14 layers
- cable O.D. 6.4 mm



I_c = 3989 A (10 cm) 3967 A (6 cm)@ 4.2 K, 15 T (J_e=122 A/mm^2)

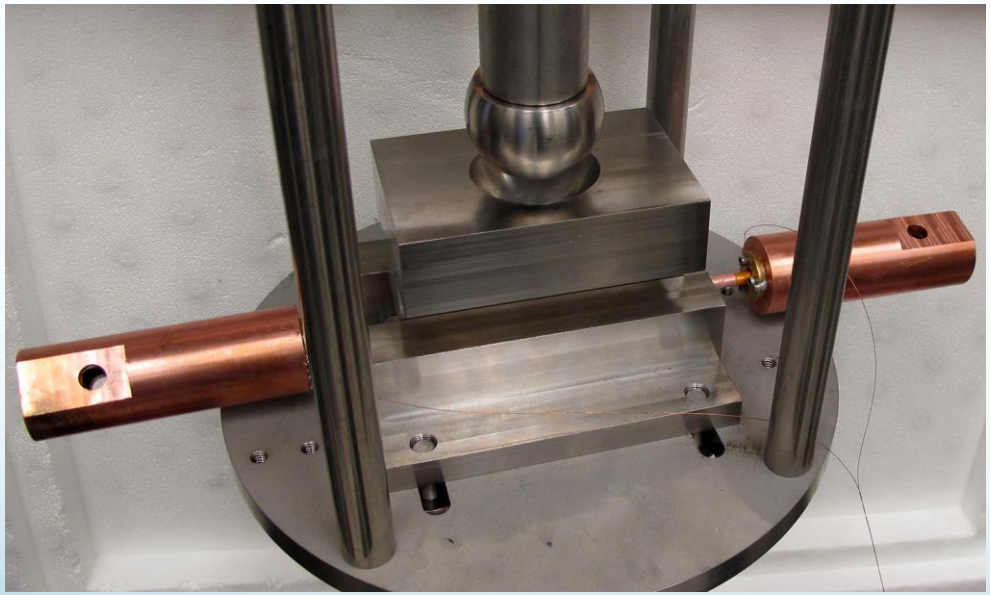
Expected J_e = 103 A/mm^2 @ 4.2 K, 20 T

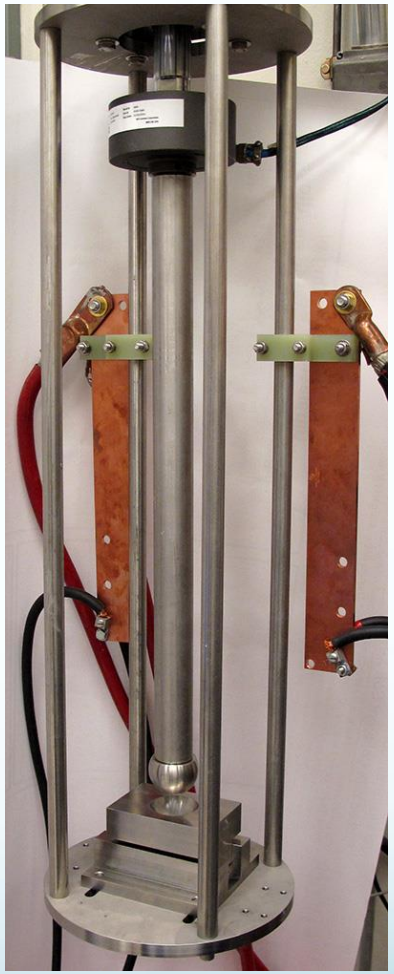
No degradation when bending from 10 cm to 6 cm: J_e(20T) = 103 A/mm^2!

Testing CORC cables under transverse compression

Compressive stress test facility at NIST:

- maximum load 10,000 lbs, or 44.5 kN.
- anvil lengths 50 mm or 100 mm.
- testing at room temperature and 76 K.
- sample current exceeding 2 kA.

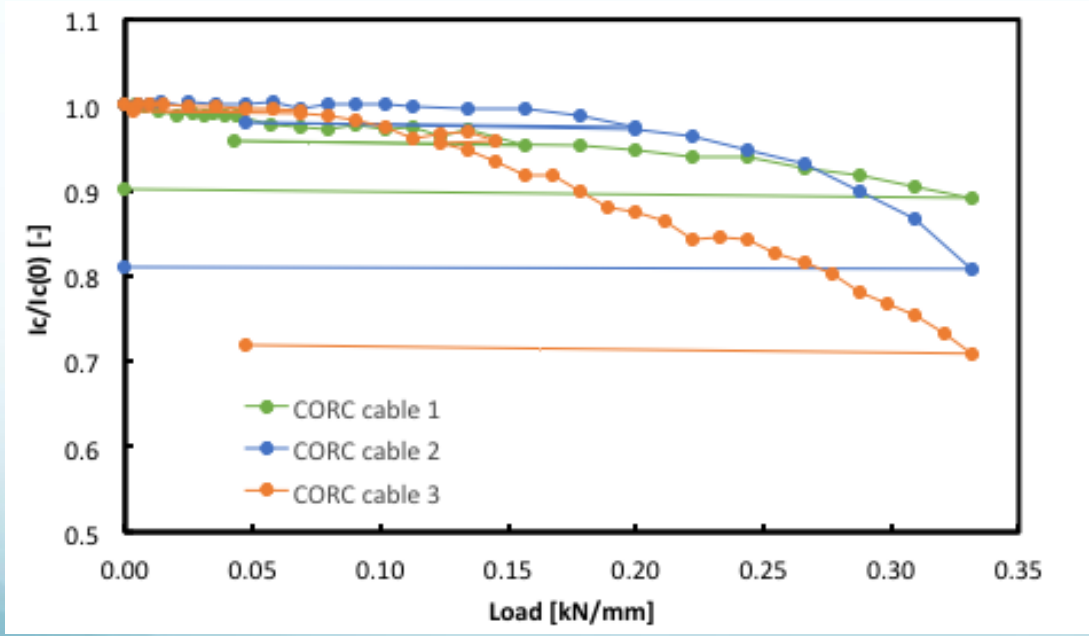




Transverse compression test results

CORC cables:
- hollow stainless steel former
- former O.D. 4.8 mm
- 3 layers

Anvil length: 10 cm.



CORC-1: 9 tapes, 0 mm gap
CORC-2: 9 tapes, 0.5 mm gap
CORC-3: 6 tapes, 1.0 mm gap

Decrease in I_c depends on gap size.

Former collapse starts at 0.3 kN/mm.

Transverse compression test results (Cont.)

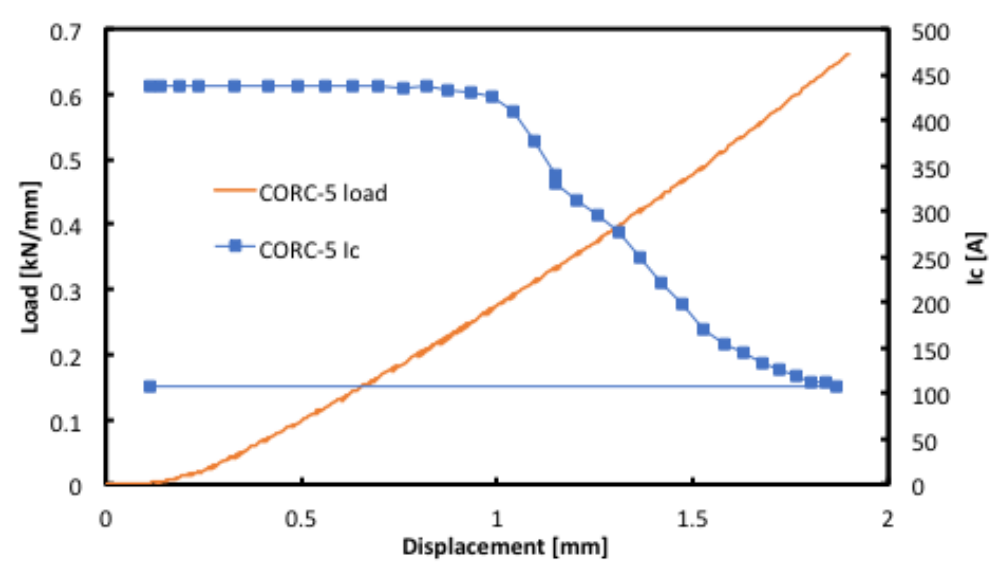
CORC cables:
- solid stainless steel former
- former O.D. 4.8 mm
- 3 layers

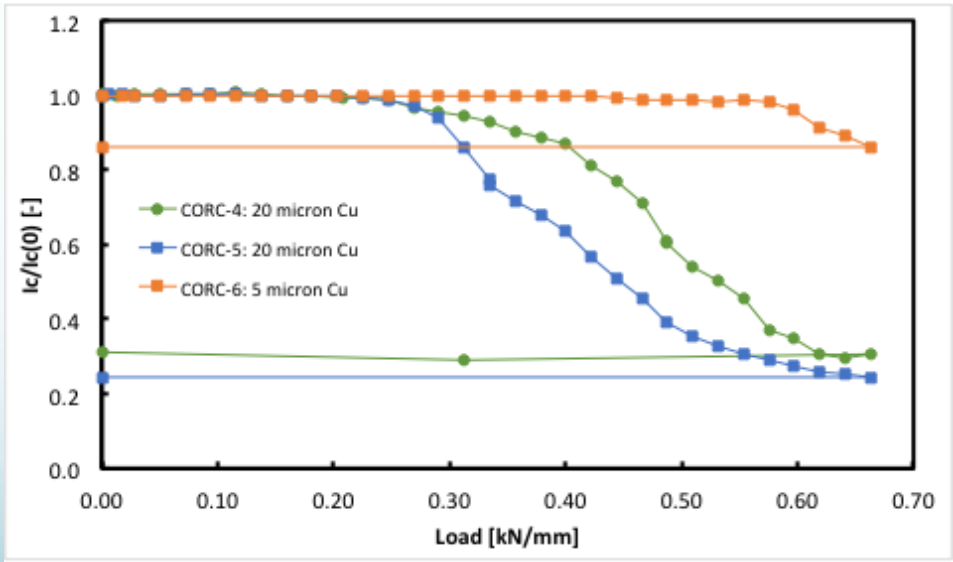
Anvil length: 5 cm.

CORC-4:
9 tapes, 0 mm gap, **20 μm Cu**
CORC-5:
9 tapes, 0.5 mm gap, **20 μm Cu**
CORC-6:
9 tapes, 0 mm gap, **5 μm Cu**

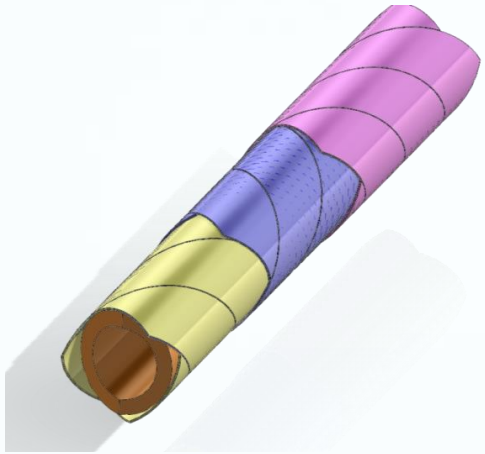
No collapse of former.

Decrease in I_c depends on gap size and copper thickness (homogeneity/dog boning?).





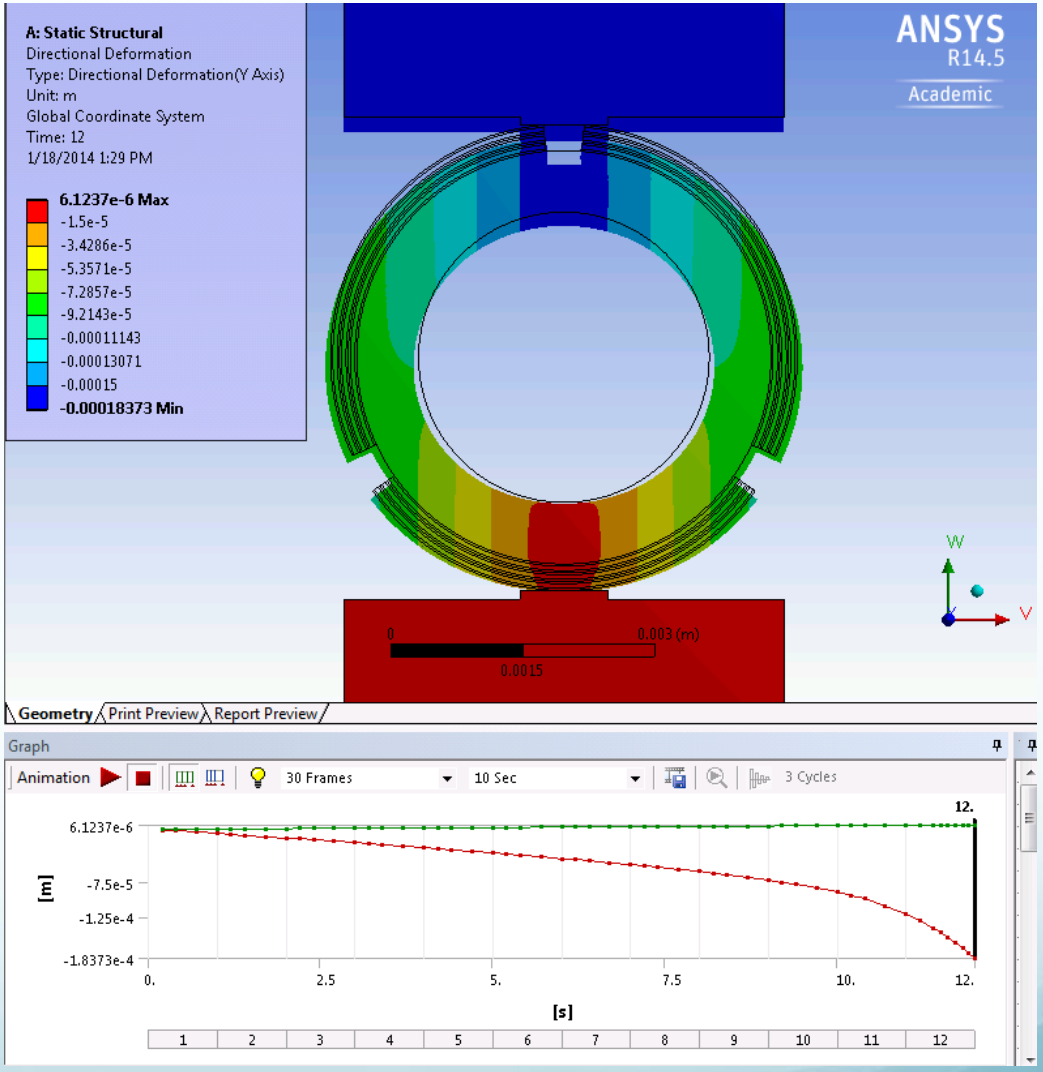
Modeling of transverse compressive stress



FE-modeling:

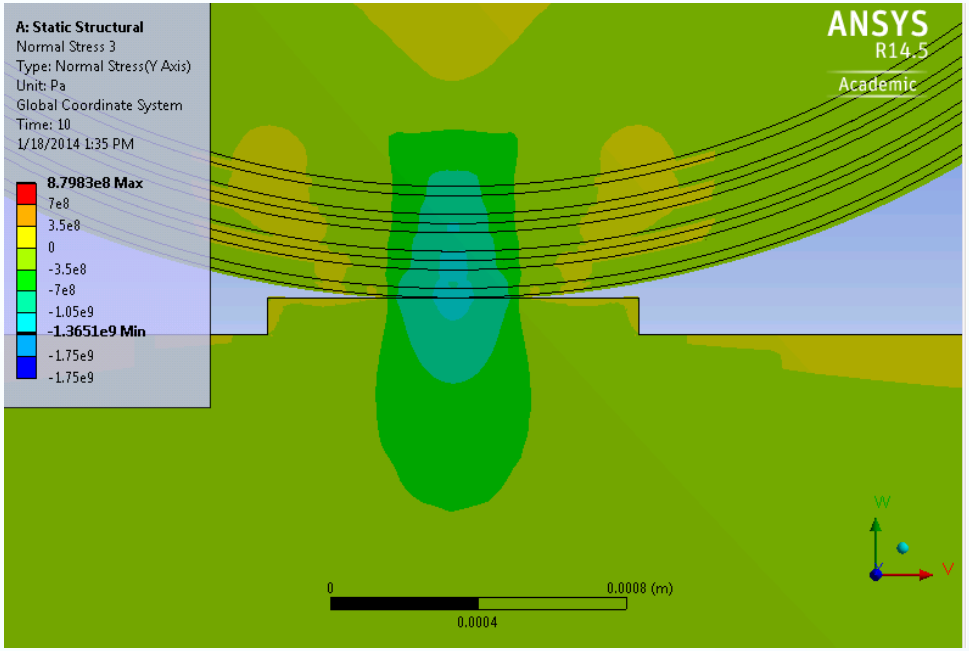
- hollow stainless steel former
- former O.D. 4.8 mm
- 3 layers of 3 tapes each
- 0.5 mm gaps

Plastic deformation of former starts at 0.28 kN/mm.



Modeling of transverse compressive stress (Cont.)

Maximum compressive stress at 7,500 lbs with 10 cm anvil: 670 MPa



0.5 mm-wide imprint in 5 cm long brass anvil after 7,500 lbs load suggests a stress of 1.3 GPa!