# Low Temperature Cracking Pooled Fund Study TPF-5(132)

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# Why do we Need a Thermal Cracking Model?

- Binder information is important, but does not completely control low temperature cracking. We also need to look at:
  - Aggregate/mastic effects on mixture creep/fracture properties
  - Effects of RAP, WMA, fibers, and other additives
  - Final, constructed mixture volumetrics – voids, aggregate structure
  - Plant/field aging
  - Structural effects of temperature profile, fracture process

# Why do we Need a Thermal Cracking Model?

- Modeling can provide:
  - True performance prediction (cracking vs. time)
  - Input for maintenance decisions
  - Insight for policy decisions

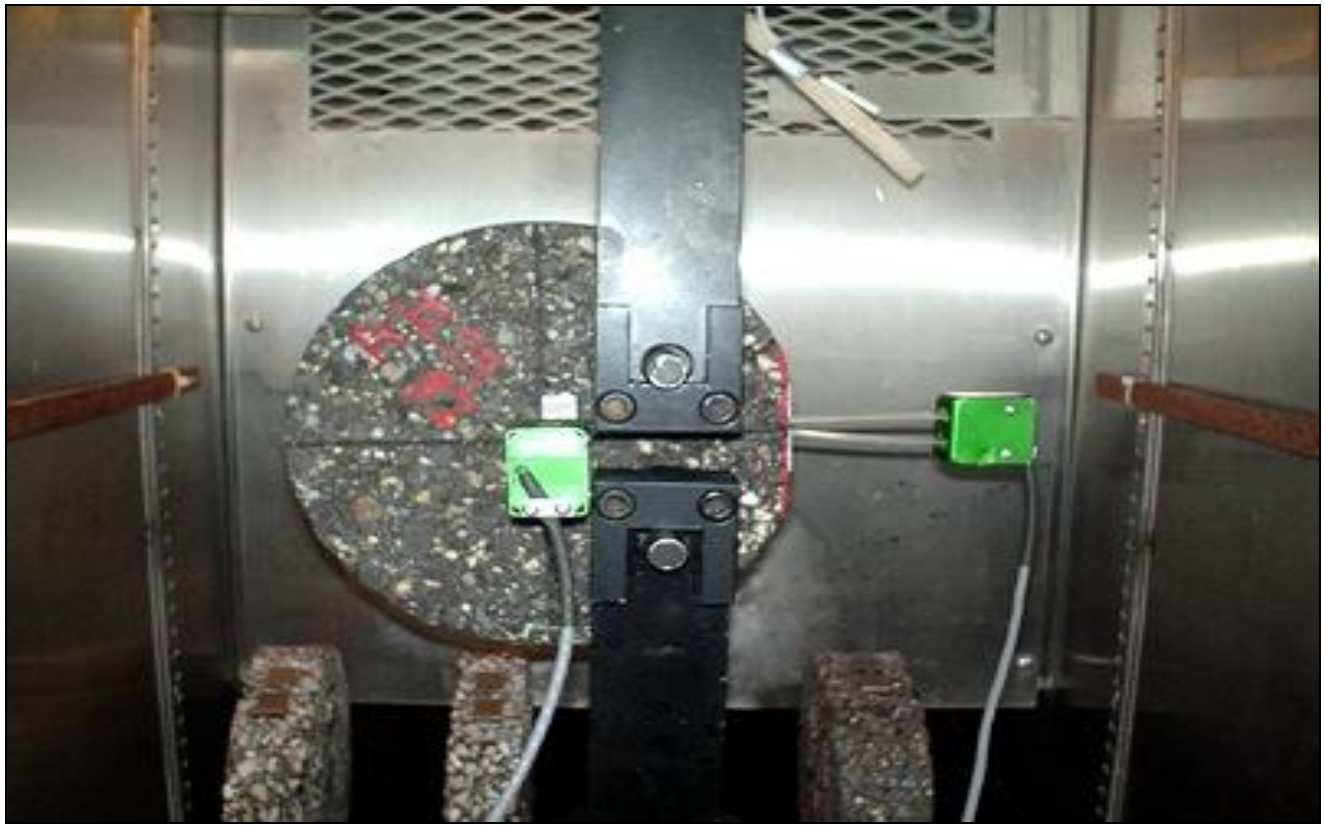
# Investigation of Low Temperature Cracking in Asphalt Pavements: National Pooled Fund Study Phase II

- **Task Number 1 -**Update on low temperature cracking research
- **Task Number 2 -**Expand Phase I test matrix with additional field samples
- **Task Number 3 -** Develop low temperature specification for asphalt mixtures

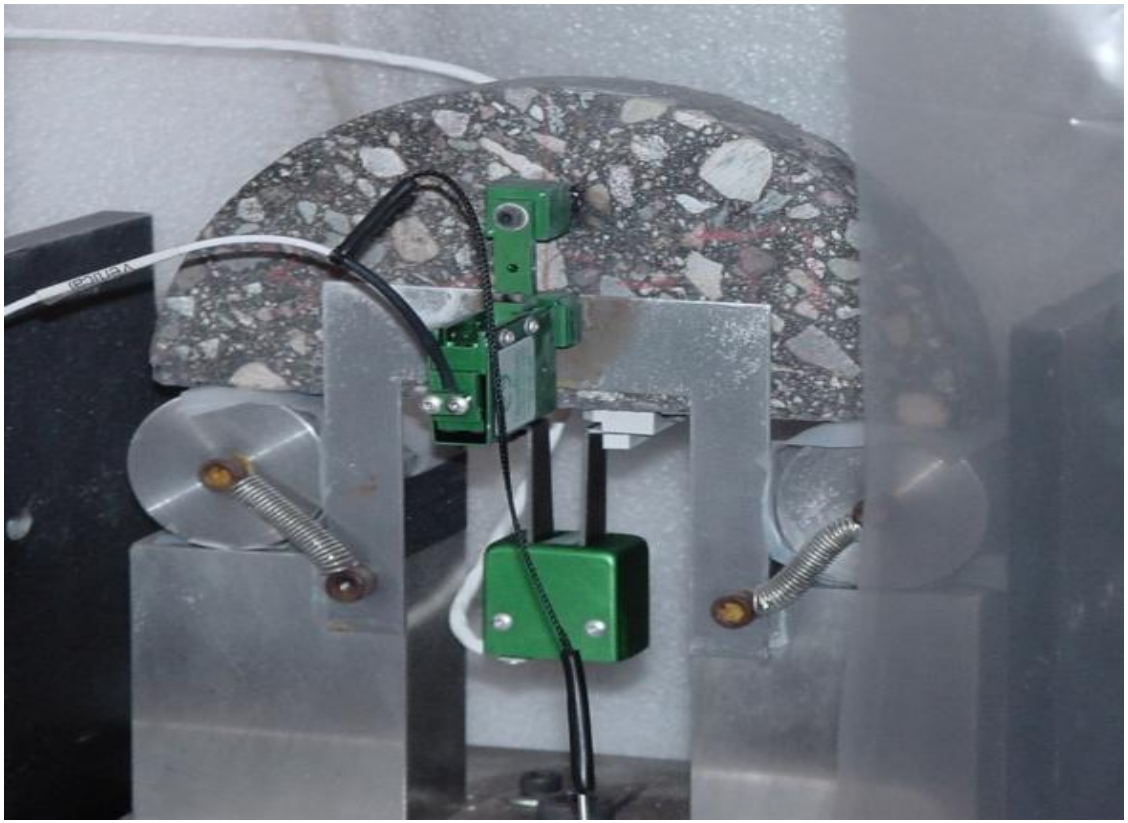
# Investigation of Low Temperature Cracking in Asphalt Pavements: National Pooled Fund Study Phase II

- **Task Number 4 -** Develop Improved TCMODEL
- **Task Number 5 -** Modeling of Asphalt Mixtures Contraction and Expansion Due to Thermal Cycling
- **Task Number 6 -** Validation of new specification
- **Task Number 7 -** Development of draft AASHTO standards and Final Report

# Disk-Shaped Compact Tension Test (DC(T))



# Semi Circular Bend Test (SCB)



## Estimated Costs

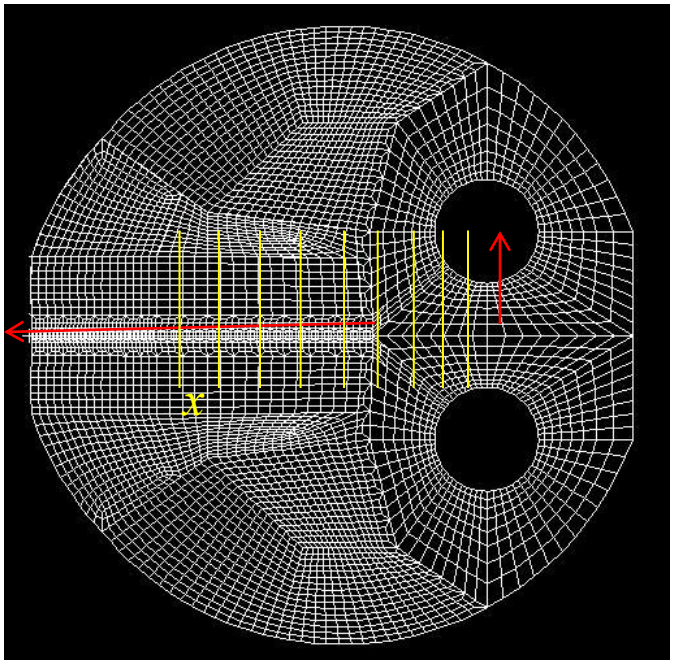
| Item | DCT | SCB |
|---|---|---|
| Loading fixtures | $3,000 | $1,000 |
| X-Y Tables to facilitate coring and sawing | $1,500 | 0 |
| CMOD Extensometer (Epsilon) | $1,400 | $1,400 |
| LLD extensometers (SCB only) | 0 | $4,000 |
| Temperature-Chamber | $20,000 | $20,000 |
| Temperature modules and thermocouples | $400 | $400 |
| PC for Data Acquisition | $1,000 | $1,000 |
| Labview Based Interface Board | $700 | $700 |
| Coring barrels (qty = 5) | $500 | 0 |
| Labview Software for Data Acquisition | $1,500 | $1,500 |
| Labview Programming | $3,000 | $3,000 |
| Dual water cooled masonry saws | $10,000 | $10,000 |
| Dual saw system for flat face and notching | $7,000 | $7,000 |
| **Total** | $50,000 | $50,000 |

# Fabrication

Notching and face cuts

Coring of loading holes

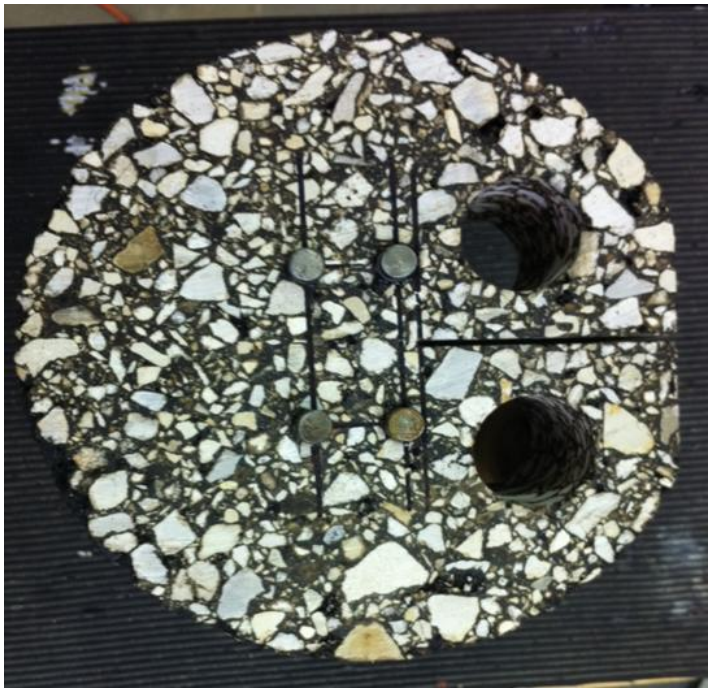
# DCT+IDT model




- Four Different FEM Models :
  - DCT specimen with notch(Elastic)
  - DCT specimen with notch(Viscoelastic)
  - DCT specimen without notch(Elastic)
  - DCT specimen without notch(Viscoelastic)

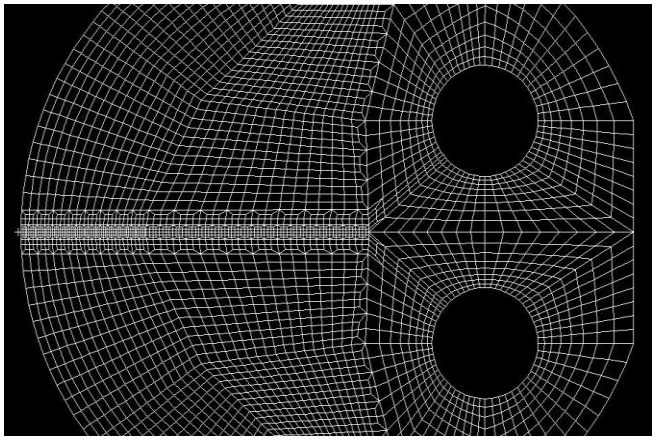
- 9 Nodesets along the X axis:

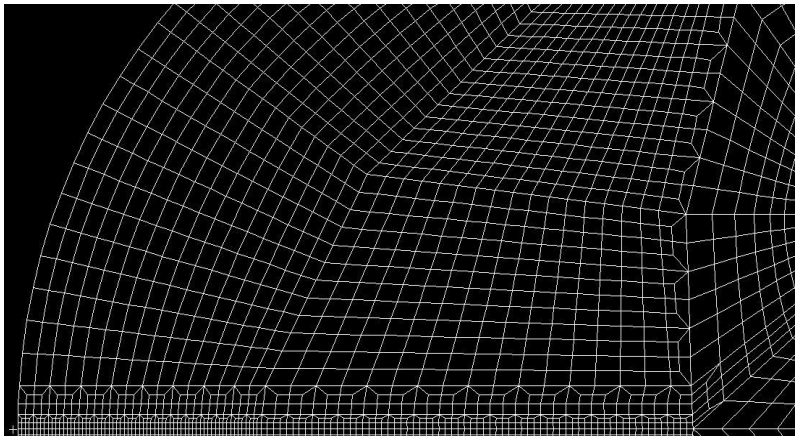
X (mm): 2, 10, 20, 30, 40, 50, 60, 70, 80



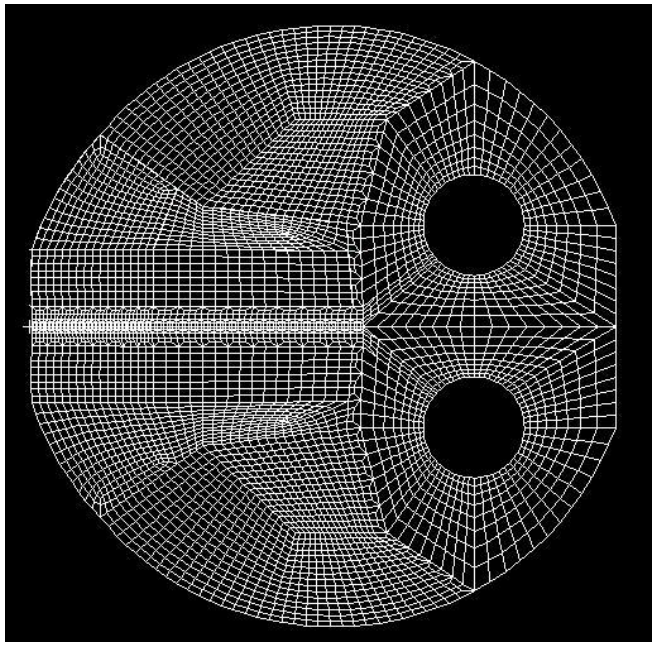
# DC(T) + IDT

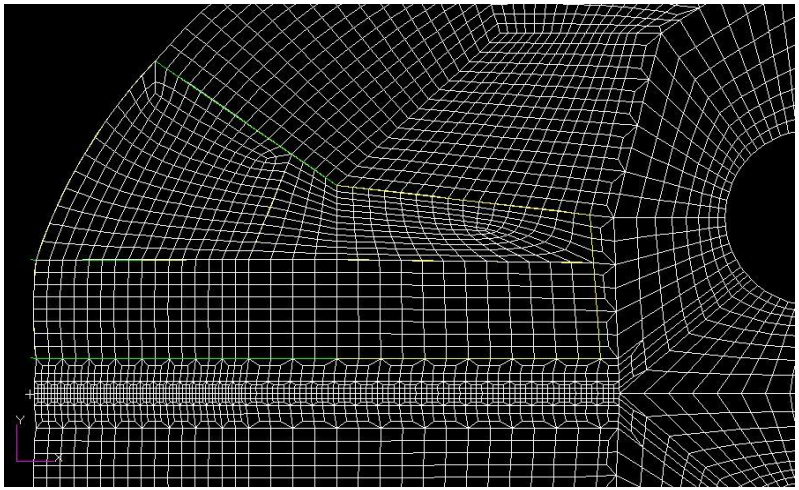
Old model





New model





# FEAE: Viscoelastic Formulation

- Recursive-incremental time integration scheme

$$\sigma\ x,t\ = \int_{t'=-\infty}^{t'=t} C\ x,\xi-\xi'\ \frac{\partial \varepsilon\ x,t'}{\partial t'}\, dt' \qquad d\boldsymbol{\sigma}\ \xi\ = \mathbf{K}\ \mathbf{x},\xi\ \times d\boldsymbol{\varepsilon}\ \xi\ + d\boldsymbol{\sigma}^{R}\ \xi$$