```
# ##########################################################################################
# SE 201B: NONLINEAR STRUCTURAL ANALYSIS
# NONLINEAR FIBER SECTION ANALYSIS
# ##########################################################################################

#Always start with
wipe; # Clear memory of all past model definitions
model BasicBuilder -ndm 2 -ndf 3; # Define the model builder, ndm=#dimension, ndf=#dofs

# ------------------------------------------------------------------------------------------
# DEFINE NODES
# ------------------------------------------------------------------------------------------
set nodeTag1 1;
set nodeTag2 2;

node $nodeTag1        0. 0.;
node $nodeTag2        0. 0.;

puts $modelExportFileID "node $nodeTag1        0. 0.;"
puts $modelExportFileID "node $nodeTag2        0. 0.;"

# ------------------------------------------------------------------------------------------
# DEFINE CONSTRAINTS
# ------------------------------------------------------------------------------------------
fix $nodeTag1         1 1 1; # Pin
fix $nodeTag2         0 1 0; # Roller

# ------------------------------------------------------------------------------------------
# DEFINE MATERIAL
# ------------------------------------------------------------------------------------------

# Define unconfined concrete material parameters
set fpc               [expr -32.2*$MPa]
set Ec                [expr 27100.0*$MPa]
set epsc0             [expr 2.0*$fpc/$Ec]
set ft                [expr 4.8*$MPa]
set lambda            0.25
set Ets               [expr 0.01*$Ec]
set fpcU              [expr 0.2*$fpc]
set epsU              -0.004

# Define confined concrete material parameters
set fpcc              [expr -53.7*$MPa]
set Ecc               [expr 27100.0*$MPa]
set epscc0            [expr 2.0*$fpcc/$Ecc]
set ftc               [expr 4.8*$MPa]
set lambdac           0.25
set Etsc              [expr 0.01*$Ecc]
set fpccU             [expr 0.85*$fpcc]
set epscU             -0.0276

# Define steel material parameters
set fy                [expr 450.0*$MPa]
set Es                [expr 218300.0*$MPa]
set b                 0.0219
set R0                20.0
set cR1               0.925
set cR2               0.15
set a1                0.0
set a2                1.0
set a3                0.0
set a4                1.0
set sigInit           0.0

set matTagConcCover 1
set matTagConcCore  2
set matTagSteel     3
set modelnum 1.0

```

```tcl
# Unconfined concrete:
uniaxialMaterial Concrete02 $matTagConcCover  $fpc $epsc0 $fpcU $epsU $lambda $ft $Ets

# Confined concrete:
uniaxialMaterial Concrete02 $matTagConcCore   $fpcc $epscc0 $fpccU $epscU $lambdac $ftc $Etsc

# Reinforcing steel:
uniaxialMaterial Steel02    $matTagSteel      $fy $Es $b $R0 $cR1 $cR2 $a1 $a2 $a3 $a4 $sigInit

puts $modelExportFileID "uniaxialMaterial Concrete02 $matTagConcCore   $fpcc $epscc0 $fpccU $epscU $lambdac $ftc $Etsc"
puts $modelExportFileID "uniaxialMaterial Concrete02 $matTagConcCover  $fpc $epsc0 $fpcU $epsU $lambda $ft $Ets"
puts $modelExportFileID "uniaxialMaterial Steel02    $matTagSteel      $fy $Es $b $R0 $cR1 $cR2 $a1 $a2 $a3 $a4 $sigInit"

# ------------------------------------------------------------------------------
# DEFINE SECTION
# ------------------------------------------------------------------------------
set colWidth    [expr 400.*$mm]
set colDepth    [expr 400.*$mm]
set colArea     [expr $colWidth * $colDepth]
set cover       [expr 40.*$mm]
set dB          [expr 20.*$mm]
set As          [expr 314.159*$mm2]
set y1          [expr $colDepth/2.0]
set z1          [expr $colWidth/2.0]
set totNumBars  8

set secTag 3
set fiberA 20
set fiberB 5
set fiberC 20

section Fiber $secTag -GJ $Ubig {
    #
    ------------------------------------------------------------------------------
    # Create rectangular patches
    #
    ------------------------------------------------------------------------------
    # Cover concrete
    patch rect $matTagConcCover $fiberA 1 [expr $cover - $y1] [expr -$z1] [expr $y1 - $cover] [expr $cover - $z1]
    patch rect $matTagConcCover $fiberA 1 [expr $cover - $y1] [expr $z1 - $cover] [expr $y1 - $cover] [expr $z1]
    patch rect $matTagConcCover $fiberB 1 [expr -$y1] [expr -$z1] [expr $cover - $y1] [expr $z1]
    patch rect $matTagConcCover $fiberB 1 [expr $y1 - $cover] [expr -$z1] [expr $y1] [expr $z1]
    # Core concrete
    patch rect $matTagConcCore $fiberC 1 [expr $cover - $y1] [expr $cover - $z1] [expr $y1 - $cover] [expr $z1 - $cover]
    #
    ------------------------------------------------------------------------------
    # Create straight layers
    #
    ------------------------------------------------------------------------------
    # Reinforcing steel
    layer straight $matTagSteel 3 $As [expr $y1 - $cover] [expr $z1 - $cover] [expr $y1 - $cover] [expr $cover - $z1]
    layer straight $matTagSteel 2 $As 0 [expr $cover - $z1] 0 [expr $z1 - $cover]
    layer straight $matTagSteel 3 $As [expr $cover - $y1] [expr $cover - $z1] [expr $cover - $y1] [expr $z1 - $cover]
}


puts $modelExportFileID "section Fiber $secTag -GJ $Ubig {
```

```
123         #
            -------------------------------------------------------------------------------
124         # Create rectangular patches
125         #
            -------------------------------------------------------------------------------
126         # Cover concrete
127         patch rect $matTagConcCover $fiberA 1 [expr $cover - $y1] [expr -$z1] [expr $y1 -
            $cover] [expr $cover - $z1]
128         patch rect $matTagConcCover $fiberA 1 [expr $cover - $y1] [expr $z1 - $cover] [expr
            $y1 - $cover] [expr $z1]
129         patch rect $matTagConcCover $fiberB 1 [expr -$y1] [expr -$z1] [expr $cover - $y1]
            [expr $z1]
130         patch rect $matTagConcCover $fiberB 1 [expr $y1 - $cover] [expr -$z1] [expr $y1]
            [expr $z1]
131         # Core concrete
132         patch rect $matTagConcCore $fiberC 1 [expr $cover - $y1] [expr $cover - $z1] [expr
            $y1 - $cover] [expr $z1 - $cover]
133         #
            -------------------------------------------------------------------------------
134         # Create straight layers
135         #
            -------------------------------------------------------------------------------
136         # Reinforcing steel
137         layer straight $matTagSteel 3 $As [expr $y1 - $cover] [expr $z1 - $cover] [expr $y1
            - $cover] [expr $cover - $z1]
138         layer straight $matTagSteel 2 $As 0 [expr $cover - $z1] 0 [expr $z1 - $cover]
139         layer straight $matTagSteel 3 $As [expr $cover - $y1] [expr $cover - $z1] [expr
            $cover - $y1] [expr $z1 - $cover]
140     }"
141
142     # ------------------------------------------------------------------------------
143     # DEFINE ELEMENT
144     # ------------------------------------------------------------------------------
145     set eleTag 1
146     set secTag 3
147     element zeroLengthSection $eleTag $nodeTag1 $nodeTag2 $secTag -orient 1 0 0 0 1 0
148     puts $modelExportFileID "element zeroLengthSection $eleTag $nodeTag1 $nodeTag2 $secTag
        -orient 1 0 0 0 1 0"
149     close $modelExportFileID
150
151     set controlNode $nodeTag2
```