1. Specimen Properties

![Specimen Properties](image)

Figure 1: Properties of Specimen 3 with spiral reinforcement.
- Unconfined concrete strength, $f'_c = 40 \text{ MPa}$
- Unconfined concrete strain at peak stress, $e_{c0} = 0.002$
- Center-to-center spiral diameter, $d_s = 50 \text{ cm}$
- Spiral bar diameter, $d_{sb} = 0.95 \text{ cm}$
- Center-to-center spiral pitch, $s = 4 \text{ cm}$
- Yield strength of confinement reinforcement, $f_{yh} = 400 \text{ MPa}$
- Strain at peak stress of confinement reinforcement, $e_{sm} = 0.09$
- Longitudinal bar diameter, $d_b = 2.54 \text{ cm}$ (bar No. 25)
- Number of longitudinal bars, $n_{lb} = 8$

2. Calculations and Equations
2.1. Areas, ratios, and coefficients

\[
A_{cc} = \frac{\pi}{4} d_s^2 - n_{lb} \frac{\pi}{4} d_{sb}^2 = 0.19 \text{ m}^2 
\]  
(1)

\[
\rho_{cc} = \frac{n_{lb} \frac{\pi}{4} d_{sb}^2}{A_{cc}} = 0.021
\]  
(2)

\[
\rho_s = \frac{\pi d_{sb}^2}{d_s s} = 0.014
\]  
(3)

Because it is spiral reinforcement,

\[
K_e = \frac{1 - s'}{1 - \rho_{cc}},
\]  
(4)

where $s'$ is found from

\[
s' = s - d_{sb} = 0.031 \text{ m},
\]  
(5)

so $K_e = 0.99$. 

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2.2. Determining $f'_{cc}$ and $e_{cc}$

The effective lateral confining pressure $f'_{l}$ is found to be

$$f'_{l} = \frac{1}{2} K_e \rho_s f_{yh} = 2.8 \text{ MPa}, \quad (6)$$

thus, the confined concrete compressive strength is

$$f'_{cc} = f'_{c}(-1.254 + 2.254 \sqrt{1 + 7.94 \frac{f'_{l}}{f'_{c}} - 2 \frac{f'_{l}}{f'_{c}}}) = 57 \text{ MPa}. \quad (7)$$

The confined concrete strain corresponding to $f'_{cc}$ can be found as

$$e_{cc} = e_{c0}[1 + 5\left(\frac{f'_{cc}}{f'_{c}} - 1\right)] = 0.0063. \quad (8)$$

2.3. Moduli of elasticity

The tangent modulus of elasticity is

$$E_c = 5000 \sqrt{f'_{c}} = 31,623 \text{ MPa}, \quad (9)$$

while $E_{sec}$ is

$$E_{sec} = \frac{f'_{cc}}{e_{cc}} = 9,048 \text{ MPa}. \quad (10)$$

Thus $r$, the ratio of $E_c$ to $E_c - E_{sec}$, equals 1.4.

2.4. Stress-strain relationship

The concrete stress-strain relationship is found from

$$f_c = \frac{f'_{cc} x r}{r - 1 + x^r} \quad (11)$$

where $x = \frac{e_c}{e_{cc}}$, and $r$ and $f'_{cc}$ are calculated above. Thus,

$$f_c = \frac{57 \times \left(\frac{e_c}{0.0063}\right) \times 1.4}{0.4 + \left(\frac{e_c}{0.0063}\right)^{1.4}} \quad (12)$$
The limiting strain for the stress-strain curve is the ultimate strain, $e_{cu}$, which is dependent on the confinement reinforcement strain at peak stress. The ultimate strain for Specimen 3 is estimated as

$$e_{cu} = 0.004 + \frac{1.4\rho_s f_{yh} e_{sm}}{f'_{cc}} = 0.016.$$  \hspace{1cm} (13)

The stress-strain curve defined by Eq. (12) is not applicable for strain values that exceed $e_{cu}$. 

3. Module Display Windows

The figures shown below are sample graphs that the module can display once a specimen has been specified and analyzed.

Figure 2: Stress-strain plot for Specimen 3 (as calculated above) is shown in white.

Figure 3: Examples of confined concrete parameters (e.g., peak stress, ultimate strain, confinement ratio) that the module windows can display.