

## รายการอ้างอิง

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ภาคผนวก ก

สมการการคืบและการหดตัวจากการสูญเสียความชื้นของคอนกรีต ตามคณะกรรมการ ACI 209 (1985)



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### สมการการคืบและการหดตัวจากการสูญเสียความชื้นของคอนกรีต

จากข้อกำหนดของคณะกรรมการ ACI 209 (1985) ได้กำหนดพหุนามิเตอร์ที่ใช้คำนวณหาค่าของสัมประสิทธิ์การคืบ และความเครียดจากการหดตัว ซึ่งขึ้นกับเวลาในการใช้งาน และคุณสมบัติของคอนกรีต

### สมการสัมประสิทธิ์การคืบ

$$\phi(t, t_0) = \frac{(t - t_0)^{0.6}}{10 + (t - t_0)^{0.6}} \phi(\infty, t_0) \quad (1)$$

$$\begin{aligned} \text{โดยที่ } t - t_0 &= \text{ช่วงระยะเวลาที่มีน้ำหนักกระทำ} \\ \phi(\infty, t_0) &= \text{สัมประสิทธิ์ของการคืบ (Ultimate creep coefficient)} \\ &= 2.35 \gamma_{la} \gamma_{\lambda} \gamma_h \gamma_s \gamma_w \gamma_a \end{aligned} \quad (2)$$

ผลของอายุของน้ำหนักกระทำ (Loading age)

$$\gamma_{la} = 1.25 (t_0)^{-0.118} \quad \text{สำหรับบ่มด้วยความชื้น} \quad (3)$$

$$= 1.13 (t_0)^{-0.095} \quad \text{สำหรับบ่มด้วยไอน้ำ} \quad (4)$$

ผลของความชื้นสัมพัทธ์ (Ambient relative humidity)

$$\gamma_{\lambda} = 1.27 - 0.0067 \lambda \quad ; \quad (\lambda > 40 \%) \quad (5)$$

$$\gamma_{\lambda} \geq 1 \quad ; \quad (\lambda < 40 \%)$$

โดยที่  $\lambda$  = เปอร์เซ็นต์ของความชื้นสัมพัทธ์ (%)

ผลของความหนาของชิ้นส่วนโดยเฉลี่ย (Average - thickness of member)

| h (mm)     | 50   | 75   | 100  | 125  | 150  |
|------------|------|------|------|------|------|
| $\gamma_h$ | 1.30 | 1.17 | 1.11 | 1.04 | 1.00 |

ค่าในตารางในใช้สำหรับ  $50 \leq h < 150$

$$\gamma_h = 1.14 - 0.00092 h \quad \text{สำหรับ } t - t_0 \leq 1 \text{ ปี} \quad (6)$$

$$= 1.10 - 0.00067 h \quad \text{สำหรับ } t - t_0 > 1 \text{ ปี} \quad (7)$$

สมการที่ (6) และ (7) ใช้สำหรับ  $150 < h < 380$

$$= \frac{2}{3} (1 + 1.13 e^{-0.0212(V/S)}) \quad \text{สำหรับ } h \geq 380 \text{ มม.} \quad (8)$$

โดยที่  $h$  = ความหนาเฉลี่ย (มม.)

ผลของค่าความยุบตัวของคอนกรีต (Slump concrete)

$$\gamma_s = 0.82 + 0.00264 (s) \quad (9)$$

โดยที่  $s$  = ค่าความยุบตัวของคอนกรีต (มม.)

ผลของเปอร์เซ็นต์มวลรวมละเอียด (Fine aggregate percentage)

$$\gamma_\psi = 0.88 + 0.0024 \psi \quad ; \quad \psi \leq 50 \% \quad (10)$$

โดยที่  $\psi$  เป็นอัตราส่วนของมวลรวมละเอียดต่อมวลรวมทั้งหมดโดยน้ำหนัก (%)

ผลของปริมาณอากาศ (Air content)

$$\gamma_\alpha = 0.46 + 0.09\alpha \geq 1 \quad (11)$$

โดยที่  $\alpha$  = ปริมาณอากาศ มีค่าเป็นเปอร์เซ็นต์

#### สมการความเครียดหดตัวจากการสูญเสียความชื้น

$$\varepsilon_{sh}(t, t_{sh}) = \frac{(t - t_{sh})}{A + (t - t_{sh})} (\varepsilon_{sh})_u \quad (12)$$

โดยที่  $t - t_{sh}$  = ช่วงระยะเวลาที่คอนกรีตเกิดการหดตัว

$A$  = 35 สำหรับการบ่มด้วยความชื้น (Moist curing)

= 55 สำหรับการบ่มด้วยไอน้ำ (Steam curing)

$(\varepsilon_{sh})_u$  = ค่าความเครียดหดตัว (Ultimate shrinkage strain)

$$= 780 \times 10^{-6} \gamma_\lambda' \gamma_h' \gamma_s' \gamma_\psi' \gamma_c' \gamma_\alpha' \gamma_{cp}' \quad (13)$$

ผลของความชื้นสัมพัทธ์ (Ambient relative humidity)

$$\gamma_\lambda' = 1.40 - 0.01\lambda \quad \text{สำหรับ } (40 \% \leq \lambda \leq 80 \%) \quad (14)$$

$$= 3.0 - 0.03\lambda \quad \text{สำหรับ } (80 \% < \lambda \leq 100 \%) \quad (15)$$

$$\geq 1.0 \quad \text{สำหรับ } \lambda < 40 \%$$

โดยที่  $\lambda$  = เปอร์เซ็นต์ของความชื้นสัมพัทธ์ (%)

ผลของความหนาของชิ้นส่วนโดยเฉลี่ย (Average - thickness of member)

|             |      |      |      |      |      |
|-------------|------|------|------|------|------|
| $h$ (mm)    | 50   | 75   | 100  | 125  | 150  |
| $\gamma_h'$ | 1.35 | 1.25 | 1.17 | 1.08 | 1.00 |

ค่าในตารางในใช้สำหรับ  $50 \leq h \leq 150$

$$\gamma_h' = 1.23 - 0.00015 h \quad \text{สำหรับ } t - t_0 \leq 1 \text{ ปี} \quad (16)$$

$$= 1.17 - 0.00015 h \quad \text{สำหรับ } t - t_0 > 1 \text{ ปี} \quad (17)$$

สมการที่ (16) และ (17) ใช้สำหรับ  $150 \leq h < 380$

$$= 1.2 e^{-0.00473(V/S)} \geq 0.20 \quad \text{สำหรับ } h \geq 380 \text{ มม.} \quad (18)$$

ผลของค่าความยุบตัวของคอนกรีต (Slump concrete)

$$\gamma_s' = 0.89 + 0.00161(s) \quad (19)$$

ผลของเปอร์เซ็นต์มวลรวมละเอียด (Fine aggregate percentage)

$$\gamma_\psi' = 0.30 + 0.014 \psi \quad \text{สำหรับ } \psi \leq 50 \% \quad (20)$$

$$= 0.90 + 0.002 \psi \quad \text{สำหรับ } \psi > 50 \% \quad (21)$$

โดยที่  $\psi$  = อัตราส่วนของมวลรวมละเอียดต่อมวลรวมทั้งหมดโดยน้ำหนัก (%)

ผลของปริมาณซีเมนต์ (Cement content)

$$\gamma_c' = 0.75 + 0.00061 C \quad (22)$$

โดยที่ C = ปริมาณซีเมนต์มีหน่วยเป็น  $kg / m^3$

ผลของปริมาณอากาศ (Air content)

$$\gamma_a' = 0.95 + 0.008\alpha \quad (23)$$

ผลของความชื้นเริ่มแรกจากการบ่ม ( $\gamma_{cp}'$ )

| ระยะเวลา (วัน) | 1   | 3   | 7   | 14   | 28   | 90   |
|----------------|-----|-----|-----|------|------|------|
| $\gamma_{cp}'$ | 1.2 | 1.1 | 1.0 | 0.93 | 0.86 | 0.75 |

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ภาคผนวก ข

สมการการวิเคราะห์การหดตัวอิสระของเสาเชิงประกอบจากผลกระทบเชิงเวลา  
โดยวิธีโมดูลปรับแก้อายุ (AEMM)



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การวิเคราะห์สมการการหดตัวอิสระของเสาเชิงประกอบโดยใช้วิธีโมดูลัสปรับแก้อายุ (AEMM)

ในการวิเคราะห์หาค่าการหดตัวของเสาที่พิจารณาผลของอีลาสติค และผลเชิงเวลารวมกันเป็นปัญหาที่มีความซับซ้อนมากเนื่องจากจะต้องคำนึงถึงคุณสมบัติของคอนกรีตที่เปลี่ยนแปลงไปตามเวลา และช่วงระยะเวลาที่มีน้ำหนักกระทำคงค้าง (Sustained loading) อยู่ตลอดเวลา ทำให้การคำนวณที่พิจารณาเฉพาะในช่วง อีลาสติคเพียงอย่างเดียวจะให้ค่าไม่ถูกต้องทั้งหมดจะต้องคำนึงถึงผลตามเวลารวมเข้าไปด้วย นอกจากนี้วิธีการวิเคราะห์ที่สามารถทำได้ตามสมการของ Beasley (1994) ที่ได้เสนอไว้แล้ว สำหรับในงานวิจัยนี้จะวิเคราะห์โดยใช้วิธีสตีฟเนสโดยตรง (Direct stiffness method) แทน เพราะว่าเป็นวิธีที่มีประสิทธิภาพนำมาใช้กับโปรแกรมคอมพิวเตอร์ และสามารถประยุกต์ใช้วิเคราะห์ผลเชิงเวลาได้ ดังนั้นจุดมุ่งหมายของการวิเคราะห์ในภาคผนวกนี้คือต้องการเปรียบเทียบสมการที่ได้จากทั้งสองวิธีว่าให้ผลลัพธ์สุดท้ายเท่ากัน โดยจะพิจารณาจากตัวอย่างง่าย ๆ ดังรูป (ข.1) ซึ่งแสดงโครงสร้างเสาสั้นหน้าตัดคอนกรีตเสริมเหล็กแบบสมมาตรรับแรงกระทำตามแนวแกนจากช่วงเวลา  $t_0$  ถึงเวลา  $t$  และสมมติว่าเวลาเริ่มต้นจากการสูญเสียความชื้น  $t_{sh}$  เท่ากับเวลาเริ่มแรกที่มีน้ำหนักกระทำ  $t_0$  วิธีการวิเคราะห์จะแบ่งเป็น 2 วิธี คือ

1. การคำนวณโดยใช้สมการหาค่าการหดตัวอย่างอิสระ (Beasley (1994))
2. การคำนวณโดยใช้วิธีสตีฟเนสโดยตรง

1. สมการหาค่าการหดตัวอย่างอิสระ (Beasley (1994))

จากสมการ (2.1) ในบทที่ 2 ได้แสดงค่าความเครียดตามแนวแกนของเสาคอนกรีตทั้งหมดที่แสดงในพจน์ผลรวมของความเครียดเริ่มแรก, ความเครียดคืบ และความเครียดหดตัวคือ

$$\varepsilon(t, t_0) = \varepsilon_e(t, t_0) + \varepsilon_c(t, t_0) + \varepsilon_{sh}(t, t_0) \quad (1)$$

จากสมการ (1) เป็นการพิจารณาว่าเสาเกิดการหดตัวอย่างอิสระผลของความเครียดคืบและความเครียดหดตัวถือว่าเป็นอิสระต่อกัน สำหรับการวิเคราะห์นี้จะพิจารณาว่าความเครียดคืบ (Creep strain) ของคอนกรีตจะขึ้นกับหน่วยแรงที่แปรเปลี่ยนไปตามเวลา ส่วนค่าความเครียดหดตัว (Shrinkage strain) จะไม่ขึ้นกับหน่วยแรง (และผลจากอุณหภูมิไม่นำมาพิจารณา) ดังนั้นจากสมการที่ (1) สามารถแสดงให้อยู่ในรูปเหมือนกับสมการที่ (2.11) ได้คือ

$$\varepsilon(t, t_0) = \frac{\sigma_c(t_0)}{E_c(t_0)} [1 + \phi(t, t_0)] + \frac{\Delta\sigma_c(t)}{E_c(t_0)} [1 + \chi\phi(t, t_0)] + \varepsilon_{sh}(t, t_0) \quad (2)$$

จากสมการที่ (2) สามารถจัดรูปได้ใหม่คือ

$$\varepsilon(t, t_0) = \frac{\sigma_c(t_0)}{E_e(t, t_0)} + \frac{\Delta\sigma_c(t)}{\bar{E}_c(t, t_0)} + \varepsilon_{sh}(t, t_0) \quad (3)$$

โดยที่  $E_e(t, t_0) = \frac{E_c(t_0)}{(1 + \phi(t, t_0))}$  ; โมดูลัสประสิทธิผล (Effective modulus)

$\bar{E}_c(t, t_0) = \frac{E_c(t_0)}{(1 + \chi\phi(t, t_0))}$  ; โมดูลัสปรับแก้อายุ (Age-adjusted effective modulus)

พิจารณาเสาคอนกรีตเสริมเหล็กลักษณะสมมาตรดังรูป (ข.1) เป็นโครงสร้างดีเทอร์มิเนต (Determinate structure) ซึ่งรับน้ำหนักบรรทุกคงที่ (P) กระทำคงค้างในแนวตั้งที่เวลา  $t_0$  แรงยึดภายนอก (P) จะถูกต้านทานจากแรงภายในของคอนกรีตและเหล็กเสริมรวมกัน โดยที่ภายใต้น้ำหนักคงค้างและหน่วยแรงคงที่หลังจากเวลา  $t_0$  จะทำให้เสาหดตัวมากขึ้นเนื่องจากความเครียดคืบ และความเครียดหดตัวที่ค่อย ๆ เกิดขึ้นมา ซึ่งทำให้เกิดความเครียดในคอนกรีตเพิ่มขึ้น

จากสมการความสมดุล (Equilibrium equation) ณ เวลา  $t$  ใดๆ ผลรวมของแรงภายในมีค่าเท่ากับแรงภายนอก

$$P = N_c(t) + N_s(t) \quad (4)$$

โดยที่  $N_c(t) =$  แรงภายในของคอนกรีต

$N_s(t) =$  แรงภายในของเหล็กเสริม

จากสมมติฐานที่ให้คอนกรีต และเหล็กเสริมเกิดการยึดเหนี่ยวกันอย่างสมบูรณ์ ดังนั้นสมการความต่อเนื่อง (Compatibility equation) ของเสาทั้งหมดระหว่างวัสดุ 2 ชนิดจะได้ว่าความเครียดของคอนกรีตทั้งหมดและความเครียดเหล็กเสริม จะเกิดขึ้นเหมือนกันทุกประการที่ทุกช่วงเวลา

$$\varepsilon(t, t_0) = \varepsilon_s(t, t_0) \quad (5)$$

เมื่อ  $\varepsilon(t, t_0) =$  ความเครียดของคอนกรีตที่เกิดขึ้นในช่วงเวลา  $t_0$  ถึงเวลา  $t$

$\varepsilon_s(t, t_0) =$  ความเครียดของเหล็กเสริมที่เกิดขึ้นในช่วงเวลา  $t_0$  ถึงเวลา  $t$

จากคุณสมบัติวัสดุของคอนกรีต (Constitutive relationship) ที่แสดงในสมการที่ (3) โดยที่เหล็กเสริมจะสมมติว่าพิจารณาเฉพาะอยู่ในช่วงความยืดหยุ่นเชิงเส้น (Linear elastic)

$$\varepsilon_s(t, t_0) = \frac{\sigma_s(t)}{E_s} \quad (6)$$

โดยที่  $E_s$  = โมดูลัสของเหล็กเสริม  
 $\sigma_s(t)$  = หน่วยแรงในเหล็กเสริมที่เวลา  $t$

ณ เวลา  $t$  ใดๆ หน่วยแรงของคอนกรีตมีค่า

$$\sigma_c(t) = \sigma_c(t_0) + \Delta\sigma_c(t) \quad (7)$$

โดยที่  $\sigma_c(t)$  = หน่วยแรงทั้งหมดที่เกิดขึ้นในคอนกรีต ณ เวลา  $t$

$$\sigma_c(t_0) = \frac{P}{A_c(1+n\rho)} ; n = \frac{E_s}{E_c(t_0)} ; \rho = \frac{A_s}{A_c}$$

= หน่วยแรงของคอนกรีตเริ่มแรกที่มีน้ำหนักกระทำทันที

$\Delta\sigma_c(t)$  = หน่วยแรงเชิงเวลาที่เปลี่ยนแปลงไปที่เกิดขึ้นจากผลของการคืบ

และหน่วยแรงเหล็กเสริมหาได้จากสมการที่ (4) ดังนี้

$$P = \sigma_c(t)A_c + \sigma_s(t)A_s$$

$$\sigma_s = \frac{P - \sigma_c(t)A_c}{A_s} \quad (8)$$

โดยที่  $A_c$  = พื้นที่หน้าตัดของคอนกรีต

$A_s$  = พื้นที่หน้าตัดของเหล็กเสริม

จากสมการที่ (3), (5), (6) และ (8) จะหาหน่วยแรงของคอนกรีตที่เวลา  $t$  ใดๆ ได้ดังสมการต่อไปนี้

$$\frac{\sigma_c(t_0)}{E_s(t, t_0)} + \frac{\Delta\sigma_c(t)}{E_c(t, t_0)} + \varepsilon_{sh}(t, t_0) = \frac{P - (\sigma_c(t) - \Delta\sigma_c(t))A_c}{E_s A_s}$$

$$\sigma_c(t_0) \left( \frac{A_c}{E_s A_s} + \frac{1}{E_c(t, t_0)} \right) + \varepsilon_{sh}(t, t_0) = \frac{P}{E_s A_s} - \Delta\sigma_c(t) \left( \frac{1}{E_c(t, t_0)} + \frac{A_c}{E_s A_s} \right) \quad (9)$$

เอา  $\bar{E}_c(t, t_0)$  คูณตลอด

$$\sigma_c(t_0) \left( \frac{A_c \bar{E}_c(t, t_0)}{E_s A_s} + \frac{\bar{E}_c(t, t_0)}{E_c(t, t_0)} \right) + \varepsilon_{sh}(t, t_0) \bar{E}_c(t, t_0) = \frac{P \bar{E}_c(t, t_0)}{E_s A_s} - \Delta\sigma_c(t) \left( 1 + \frac{\bar{E}_c(t, t_0) A_c}{E_s A_s} \right)$$

ให้  
 $\rho = \frac{A_s}{A_c}$

$$n_e = \frac{E_s (1 + \phi(t, t_0))}{E_c(t_0)} = \frac{E_s}{E_c(t, t_0)}$$

$$n_e' = \frac{E_s (1 + \chi \phi(t, t_0))}{E_c(t_0)} = \frac{E_s}{\bar{E}_c(t, t_0)}$$

$$\begin{aligned} \Delta\sigma_c(t) \left( 1 + \frac{1}{n_e' \rho} \right) &= \frac{P}{A_s n_e'} - \sigma_c(t_0) \left( \frac{1}{n_e' \rho} + \frac{\bar{E}_c(t, t_0)}{E_c(t, t_0)} \right) - \varepsilon_{sh}(t, t_0) \bar{E}_c(t, t_0) \\ &= \frac{P}{A_s n_e'} - \sigma_c(t_0) \left( \frac{E_c(t, t_0) + n_e' \rho \bar{E}_c(t, t_0)}{E_c(t, t_0) n_e' \rho} \right) - \varepsilon_{sh}(t, t_0) \bar{E}_c(t, t_0) \\ &= \frac{P}{A_s n_e'} - \sigma_c(t_0) \left( \frac{1 + \frac{\bar{E}_c(t, t_0) E_s \rho}{E_c(t, t_0) \bar{E}_c(t, t_0)}}{n_e' \rho} \right) - \varepsilon_{sh}(t, t_0) \bar{E}_c(t, t_0) \end{aligned}$$

$$= \frac{P}{A_s n_e'} - \sigma_c(t_0) \left( \frac{1 + n_e \rho}{n_e' \rho} \right) - \varepsilon_{sh}(t, t_0) \bar{E}_c(t, t_0)$$

$$\begin{aligned} \Delta\sigma_c(t) &= \frac{n_e' \rho}{1 + n_e' \rho} \left( \frac{P}{A_s n_e'} - \sigma_c(t_0) \left( \frac{1 + n_e \rho}{n_e' \rho} \right) - \varepsilon_{sh}(t, t_0) \bar{E}_c(t, t_0) \right) \\ &= \frac{\rho}{1 + n_e' \rho} \left( \frac{P}{A_s} - \sigma_c(t_0) \left( \frac{1 + n_e \rho}{\rho} \right) - \varepsilon_{sh}(t, t_0) E_s \right) \end{aligned}$$

(10)

แทนค่า  $\Delta\sigma_c(t)$  ลงในสมการที่ (2) จะได้

$$\begin{aligned} \varepsilon(t, t_0) &= \frac{\sigma_c(t_0)}{E_c(t_0)} (1 + \phi(t, t_0)) + \frac{\rho}{E_c(t_0) (1 + n_e' \rho)} \\ &\quad \left( \frac{P}{A_s} - \frac{\sigma_c(t_0) (1 + n_e \rho)}{\rho} - \varepsilon_{sh}(t, t_0) E_s \right) (1 + \chi \phi(t, t_0)) + \varepsilon_{sh}(t, t_0) \end{aligned} \quad (11)$$

จากสมการที่ (9) ถ้าให้ค่า  $\Delta\sigma_c(t) = 0$  ;  $\chi(t, t_0) = 1$  ;  $\phi(t, t_0) = 0$   
 $\varepsilon_{sh}(t, t_0) = 0$  ;  $E_e(t, t_0) = \bar{E}_e(t, t_0) = E_c(t_0)$

$$\frac{\sigma_c(t_0)}{E_c(t_0)} + \varepsilon_{sh}(t, t_0) = \frac{P - \sigma_c(t_0)A_c}{E_s A_s}$$

$$\sigma_c(t_0) \left( \frac{1}{E_c(t_0)} + \frac{A_c}{E_s A_s} \right) = \frac{P}{A_s E_s}$$

คูณ  $E_c(t_0)$  ตลอดจะได้

$$\sigma_c(t_0) \left( 1 + \frac{1}{n\rho} \right) = \frac{P}{nA_s}$$

$$\sigma_c(t_0) = \frac{P}{nA_s \left( 1 + \frac{1}{n\rho} \right)}$$

$$= \frac{P\rho}{A_s (1 + n\rho)}$$

$$= \frac{P}{A_c (1 + n\rho)} \quad (12)$$

แทนค่าสมการที่ (12) ลงในสมการที่ (11) จะได้

$$\varepsilon(t, t_0) = \frac{P(1 + \phi(t, t_0))}{A_c(1 + n\rho)E_c(t_0)} + \frac{\rho}{E_c(t_0)(1 + n_e'\rho)} \left( \frac{P}{A_s} - \frac{P(1 + n_e\rho)}{A_c\rho(1 + n\rho)} - \varepsilon_{sh}(t, t_0)E_s \right)$$

$$= \frac{P(1 + \phi(t, t_0))}{A_c E_c(t_0)(1 + n\rho)} + \left( \frac{P\rho}{A_s E_c(t_0)(1 + n_e'\rho)} - \frac{P(1 + n_e\rho)}{A_c E_c(t_0)(1 + n_e'\rho)(1 + n\rho)} \right)$$

$$(1 + \chi\phi(t, t_0)) + \varepsilon_{sh}(t, t_0) - \varepsilon_{sh}(t, t_0)E_s \frac{\rho(1 + \chi\phi(t, t_0))}{E_c(t_0)(1 + n_e'\rho)}$$

$$= \frac{P(1 + \phi(t, t_0))}{A_c E_c(t_0)(1 + n\rho)} + \frac{P(1 + \chi\phi(t, t_0))}{A_c E_c(t_0)} \left( \frac{1}{(1 + n_e'\rho)} - \frac{(1 + n_e\rho)}{(1 + n_e'\rho)(1 + n\rho)} \right)$$

$$+ \varepsilon_{sh}(t, t_0) - \varepsilon_{sh}(t, t_0)E_s \frac{\rho(1 + \chi\phi(t, t_0))}{E_c(t_0)(1 + n_e'\rho)}$$

$$\begin{aligned}
&= \frac{P(1+\phi(t,t_0))}{A_c E_c(t_0)(1+n\rho)} + \frac{P(1+\chi\phi(t,t_0))}{A_c E_c(t_0)} \left( \frac{(1+n\rho)-(1+n_e\rho)}{(1+n_e'\rho)(1+n\rho)} \right) + \varepsilon_{sh}(t,t_0) \\
&\quad - \frac{\varepsilon_{sh}(t,t_0)n_e'\rho}{1+n_e'\rho} \\
&= \frac{P(1+\phi(t,t_0))}{A_c E_c(t_0)(1+n\rho)} + \frac{P\rho(n-n_e)(1+\chi\phi(t,t_0))}{A_c E_c(t_0)(1+n\rho)(1+n_e'\rho)} - \varepsilon_{sh}(t,t_0) \frac{n_e'\rho}{1+n_e'\rho} \\
&\quad + \varepsilon_{sh}(t,t_0)
\end{aligned} \tag{13}$$

จากคุณสมบัติการหดตัวของเสาในช่วงอีลาสติกคือ

$$\delta(t,t_0) = \varepsilon(t,t_0) L \tag{14}$$

แทนค่าสมการที่ (14) ลงในสมการที่ (13) จะได้

$$\begin{aligned}
\delta(t,t_0) &= \frac{PL(1+\phi(t,t_0))}{A_c E_c(t_0)(1+n\rho)} + \frac{PL\rho(n-n_e)(1+\chi\phi(t,t_0))}{A_c E_c(t_0)(1+n\rho)(1+n_e'\rho)} - \varepsilon_{sh}(t,t_0) \frac{L n_e'\rho}{1+n_e'\rho} \\
&\quad + \varepsilon_{sh}(t,t_0) L
\end{aligned} \tag{15}$$

จากสมการที่ (15) เป็นสมการหาค่าการหดตัวของเสาทั้งหมดภายใต้น้ำหนักกระทำตามแนวแกนของช่วงอีลาสติกและเชิงเวลารวมกัน ถ้าพิจารณาน้ำหนักกระทำ  $P$  ในเสาที่มีความยาว  $L$  เป็นน้ำหนักที่เพิ่มขึ้น  $P_i$  ตามขั้นตอนจนถึงขั้นตอนสุดท้าย  $P_k$  สามารถจะแยกพจน์ตัวประกอบของการหดตัวออกได้ 4 พจน์ ตามสมการที่แสดงต่อไปนี้เป็นคือ

$$\delta(t,t_0)_{Total} = \delta(t_0)_{Elastic} + \delta(t,t_0)_{Creep} + \delta(t,t_0)_{Shrinkage} + \delta(t,t_0)_{Reinforcement} \tag{16}$$

เมื่อ  $\delta(t,t_0)_{Total}$  = การหดตัวทั้งหมดของเสาในช่วงเวลา  $t_0$  ถึงเวลา  $t$

$\delta(t_0)_{Elastic}$  = การหดตัวของเสาในช่วงอีลาสติก ณ เวลา  $t_0$

$$= \sum_{i=1}^k \left( \frac{P_i L}{A_c E_c(t_0)_i (1+n_i \rho)} \right) \tag{17.1}$$

$\delta(t,t_0)_{creep}$  = การหดตัวของเสาจากผลของการคืบ (Creep) ในช่วงเวลา  $t_0$  ถึงเวลา  $t$

$$= -\delta_{Elastic} + \sum_{i=1}^k \left( \frac{P_i L (1 + \phi(t, t_0)_i)}{A_c E_c(t_0)_i (1 + n_i \rho)} \right) + \sum_{i=1}^k \left( \frac{P_i L \rho (n_i - n_{ei}) (1 + \chi_i \phi(t, t_0)_i)}{A_c E_c(t_0)_i (1 + n_i \rho) (1 + n_{ei}' \rho)} \right) \quad (17.2)$$

$$\delta(t, t_0)_{Shrinkage} = \text{การหดตัวของเสาจากการสูญเสียความชื้นในคอนกรีตในช่วงเวลา } t_0 \text{ ถึงเวลา } t \\ = \varepsilon_{sh}(t, t_0) L \quad (17.3)$$

$$\delta(t, t_0)_{Reinforcement} = \text{การหดตัวของเสาจากผลของเหล็กเสริมในคอนกรีต} \\ = -\varepsilon_{sh}(t, t_0) L \frac{\rho n_{ei}'}{1 + n_{ei}' \rho} \quad (17.4)$$

$k$  = จำนวนชุดน้ำหนักที่มากระทำต่อโครงสร้าง

$\rho$  = แปรผันเริ่มต้นของเหล็กเสริมในคอนกรีต

$$= \frac{A_s}{A_c} \quad (17.5)$$

$$n_i = \frac{E_s}{E_c(t_0)_i} \quad (17.6)$$

$$n_{ei} = \frac{E_s (1 + \phi(t, t_0)_i)}{E_c(t_0)_i} \quad (17.7)$$

$$n_{ei}' = \frac{E_s (1 + \chi \phi(t, t_0)_i)}{E_c(t_0)_i} \quad (17.8)$$

เพราะฉะนั้นการหดตัวสะสมของเสาตามจำนวนชั้นภายใต้น้ำหนักกระทำ สามารถแสดงได้ดังสมการต่อไปนี้

$$\delta_{Cumulative} = \sum_{i=1}^j \delta_{Total \text{ for } i^{th} \text{ Storey}} \quad (18)$$

โดยที่  $\delta_{Cumulative}$  = การหดตัวสะสมของเสาในแต่ละชั้น

$j$  = จำนวนชั้นทั้งหมดในโครงสร้าง

ส่วนหน่วยแรงในคอนกรีตทั้งหมดเนื่องจากน้ำหนักกระทำ  $P$  ที่เวลาเริ่มแรก  $t_0$  จะพิจารณาจากการแทนค่าสมการที่ (10) และสมการที่ (12) ลงในสมการที่ (7) จะได้ว่า

$$\sigma_c(t) = \frac{P (\rho (n - n_e + n_e') + 1)}{A_c (1 + \rho n) (1 + \rho n_e')} \quad (19)$$



ดังนั้นถ้าพิจารณาน้ำหนักที่กระทำกับเสาเพิ่มขึ้นทั้งหมดจำนวน  $k$  ชุด โดยให้  $P_i$  เป็นน้ำหนักกระทำที่เวลาเริ่มแรก ( $t_0$ ) หน่วยแรงทั้งหมดในคอนกรีตที่เกิดขึ้นแสดงได้ดังสมการ

$$\sigma_{c,ec}(t) = \sum_{i=1}^k \frac{P_i (\rho (n_i - n_{ei} + n_{ei}') + 1)}{A_c (1 + \rho n_i) (1 + \rho n_{ei}')} \quad (20)$$

และ

$$\sigma_{c,sh}(t) = \frac{-\varepsilon_{sh}(t, t_0) \rho E_s}{(1 + \rho n_{ei}')} \quad (21)$$

โดยที่  $\sigma_{c,ec}(t)$  = หน่วยแรงทั้งหมดในคอนกรีตเนื่องจากผลการเปลี่ยนแปลงในช่วงฮีสทรีติกและการคืบในช่วงเวลา  $t_0$  ถึงเวลา  $t$   
 $\sigma_{c,sh}(t)$  = หน่วยแรงทั้งหมดในคอนกรีตเนื่องจากการหดตัวจากการสูญเสียความชื้นในช่วงเวลา  $t_0$  ถึงเวลา  $t$

จากสมการความสมดุลจะได้ว่าหน่วยแรงที่เกิดขึ้นในเหล็กเสริม แสดงได้ตามสมการต่อไปนี้คือ

$$\sigma_s(t) = \frac{P_{total} - A_c (\sigma_{c,ec}(t) + \sigma_{c,sh}(t))}{A_s} \quad (22)$$

โดยที่  $P_{total}$  = น้ำหนักทั้งหมดที่กระทำกับเสา  
 $= \sum_{i=1}^k P_i$

## 2. การคำนวณโดยใช้วิธีลัดไฟเนลโดยตรง

สำหรับการวิเคราะห์หาค่าการหดตัวของเสาในบทที่ 3 เป็นตามวิธีลัดไฟเนลโดยตรง สามารถจะวิเคราะห์ได้ทั้งในกรณีการหดตัวอย่างอิสระ (Free column shortening) และการหดตัวที่มีการยึดรั้งของคาน (Frame interaction) แต่ในการวิเคราะห์โดยใช้วิธีคำนวณโดยตรงตามสมการข้างบนจะวิเคราะห์ได้เฉพาะการหดตัวอย่างอิสระเท่านั้น ดังนั้นการวิเคราะห์จะแบ่งการพิจารณาออกเป็น 2 ช่วงเวลาคือ ช่วงฮีสทรีติก และช่วงคิดผลเชิงเวลา

การวิเคราะห์ในช่วงของอีลาสติก (Elastic analysis)

จากสมการที่ (3.12) ณ เวลา  $t_0$

$$[K]_{t_0} \{u\}_{t_0} = \{P\}_{t_0}$$

โดยที่  $[K]_{t_0} = [K^c]_{t_0} + [K^s]$  (จากสมการที่ (3.10) และ (3.11) ตามลำดับ)

$$\{u\}_{t_0} = \{u_1, u_2, w_1, w_2, \theta_1, \theta_2\}$$

$$\{P\} = \{0, -P, 0, 0, 0, 0\}$$

จากรูป (ข.1) พบว่ามีการพิจารณาเฉพาะน้ำหนักที่กระทำตามแนวแกนเท่านั้น ทำให้ลดดิฟเฟอเรนเชียลส่วนใหญ่มักมีค่าเป็นศูนย์ เมื่อขจัดพจน์ที่เป็นศูนย์ออกไปจะได้สมการง่าย ๆ คือ

$$\left( \frac{E_c(t_0)A_c}{L} + \frac{E_s A_s}{L} \right) u_2(t_0) = -P$$

$$u_2(t_0) = -\frac{P L}{A_c E_c(t_0) + A_s E_s} = -\frac{P L}{A_c E_c(t_0)(1+n\rho)} \quad (23)$$

การวิเคราะห์เชิงเวลา (Time dependent analysis) จากเวลา  $t_0$  ถึงเวลา  $t$

จากสมการที่ (3.15) และ (3.16) จะให้ค่าความเครียดที่เพิ่มขึ้นหลังจากปล่อยให้โครงสร้างเกิดการคืบอย่างอิสระ

$$\Delta \varepsilon(t, t_0) = \phi(t, t_0) \left( \frac{P}{A_c E_c(t_0) + A_s E_s} \right) + \varepsilon_{sh}(t, t_0)$$

$$\Delta \psi(t, t_0) = \phi(t, t_0) \psi(t_0) = 0$$

คำนวณค่าการเปลี่ยนแปลงตำแหน่งที่ข้อต่อของโครงสร้าง โดยใช้หลักการสมมติ (Principle of virtual work) จากสมการที่ (3.17) ถึง (3.19)

$$\Delta \theta_1(t, t_0) = \int_0^L \Delta \psi(t, t_0) m_1 dx = 0$$

$$\Delta \theta_2(t, t_0) = \int_0^L \Delta \psi(t, t_0) m_2 dx = 0$$

$$\begin{aligned}\Delta L(t, t_0) &= \int_0^L \left( \phi(t, t_0) \left( \frac{P}{A_c E_c(t_0) + A_s E_s} \right) + \varepsilon_{sh}(t, t_0) \right) (1) dx \\ &= \phi(t, t_0) \left( \frac{PL}{A_c E_c(t_0) + A_s E_s} \right) + \varepsilon_{sh}(t, t_0) L\end{aligned}$$

แรงยึดรั้งสมมติ (Artificial restraint) ที่เกิดขึ้นในโครงสร้าง ตามสมการที่ (3.20) ถึง (3.22) จะได้

$$\begin{aligned}\begin{Bmatrix} N_1 \\ N_2 \end{Bmatrix}_{t, t_0} &= - \frac{\bar{E}_c(t, t_0) A_c \Delta L(t, t_0)}{L} \begin{Bmatrix} 1 \\ -1 \end{Bmatrix} = \begin{Bmatrix} -N_1 \\ N_2 \end{Bmatrix}_{t, t_0} \\ \begin{Bmatrix} V_1 \\ V_2 \end{Bmatrix}_{t, t_0} &= - \frac{(\Delta M_1 + \Delta M_2)}{L} \begin{Bmatrix} 1 \\ -1 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix} \\ \begin{Bmatrix} M_1 \\ M_2 \end{Bmatrix}_{t, t_0} &= - \frac{\bar{E}_c(t, t_0) I_c}{L} \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix} \begin{Bmatrix} \Delta \theta_1 \\ \Delta \theta_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix} \\ \{F\}_{t, t_0} &= \{N_1, N_2, V_1, V_2, M_1, M_2\}_{t, t_0}\end{aligned}$$

พิจารณาสมการในลของคอนกรีตที่คิดผลเชิงเวลาและเหล็กเสริมเข้าด้วยกันจะได้

$$[K']_{t, t_0} \{\Delta u\}_{t, t_0} = -\{F\}_{t, t_0}$$

$$\text{โดยที่ } [K']_{t, t_0} = [K']_{t, t_0} + [K^s] \quad (\text{จากสมการที่ 3.25})$$

$$\{\Delta u\}_{t, t_0} = \{\Delta u_1, \Delta u_2, \Delta w_1, \Delta w_2, \Delta \theta_1, \Delta \theta_2\}$$

$$\{F\}_{t, t_0} = \{-N_1, N_2, 0, 0, 0, 0\}$$

การแก้สมการในส่วนคิดผลเชิงเวลานี้จะมีลักษณะคล้ายกับสมการในช่วงของอีลาสติค โดยจะมีพจน์ส่วนใหญ่ที่เป็นศูนย์ไม่จำเป็นต้องนำมาพิจารณาทำให้เหลือพจน์ที่คิดการเปลี่ยนแปลงตามแนวแกนเท่านั้นคือ

$$\begin{aligned}\left\{ \frac{\bar{E}_c(t, t_0) A_c}{L} + \frac{E_s A_s}{L} \right\} \{\Delta u_2(t, t_0)\} &= -N_2(t, t_0) \\ \Delta u_2(t, t_0) &= - \frac{L}{\bar{E}_c(t, t_0) A_c + E_s A_s} \left\{ \bar{E}_c(t, t_0) A_c (\phi(t, t_0) \varepsilon(t_0) + \varepsilon_{sh}(t, t_0)) \right\}\end{aligned}$$

$$\text{ถ้าให้ } \bar{A} = A_c + n_e' A_s$$

และ  $n_e' = \frac{E_s}{E_c(t_0)}(1 + \chi \phi(t, t_0))$  สามารถจะเขียนสมการข้างต้นใหม่ได้เป็น

$$\begin{aligned} \Delta u_2(t, t_0) &= -\frac{L}{\bar{E}_c(t, t_0) \bar{A}} \left[ \bar{E}_c(t, t_0) A_c (\phi(t, t_0) \varepsilon_0(t_0) + \varepsilon_{sh}(t, t_0)) \right] \\ &= -\left( \frac{P \phi(t, t_0) A_c L}{E_c(t_0) A \bar{A}} + \varepsilon_{sh}(t, t_0) \frac{A_c L}{\bar{A}} \right) \\ &= -\left( \frac{P \phi(t, t_0) L}{E_c(t_0)} \left( \frac{\bar{A} - n_e' A_s}{\bar{A} A} \right) + \varepsilon_{sh}(t, t_0) \frac{A_c L}{\bar{A}} \right) \\ &= -\left( \frac{P \phi(t, t_0) L}{E_c(t_0) A} - \frac{P \phi(t, t_0) n_e' A_s L}{E_c(t_0) A \bar{A}} + \varepsilon_{sh}(t, t_0) \frac{A_c L}{A_c + n_e' A_s} \right) \end{aligned}$$

โดยที่  $A = A_c (1 + n \rho)$  เพราะฉะนั้น

$$\begin{aligned} \Delta u_2(t, t_0) &= -\frac{P \phi(t, t_0) L}{E_c(t_0) A_c (1 + n \rho)} + \frac{P \phi(t, t_0) L n_e' A_s}{E_c(t_0) A_c (1 + n \rho) A_c (1 + n_e' \rho)} - \frac{\varepsilon_{sh}(t, t_0) L}{1 + n_e' \rho} \\ &= -\frac{P \phi(t, t_0) L}{E_c(t_0) A_c (1 + n \rho)} + \frac{P \phi(t, t_0) L \rho \left( \frac{E_s}{E_c(t_0)} (1 + \chi \phi(t, t_0)) \right)}{E_c(t_0) A_c (1 + n \rho) (1 + n_e' \rho)} - \frac{\varepsilon_{sh}(t, t_0) L}{1 + n_e' \rho} \\ &= -\frac{P \phi(t, t_0) L}{E_c(t_0) A_c (1 + n \rho)} + \frac{P L \rho \left( \frac{E_s}{E_c(t_0)} (1 + \phi(t, t_0)) - \frac{E_s}{E_c(t_0)} \right) (1 + \chi \phi(t, t_0))}{E_c(t_0) A_c (1 + n \rho) (1 + n_e' \rho)} \\ &\quad - \frac{\varepsilon_{sh}(t, t_0) L}{1 + n_e' \rho} \end{aligned} \tag{24}$$

$$\text{ให้ } n_e = \frac{E_s}{E_c(t_0)} (1 + \phi(t, t_0))$$

ดังนั้นสมการการหดตัวเชิงเวลา (24) สามารถจะเขียนให้อยู่ในรูปใหม่ได้เป็น

$$\Delta u_2(t, t_0) = -\frac{P L \phi(t, t_0)}{E_c(t_0) A_c (1 + n \rho)} + \frac{P L \rho (n_e - n) (1 + \chi \phi(t, t_0))}{E_c(t_0) A_c (1 + n \rho) (1 + n_e' \rho)} - \frac{\varepsilon_{sh}(t, t_0) L}{1 + n_e' \rho} \tag{25}$$

เพราะฉะนั้นการหดตัวทั้งหมดที่เกิดขึ้นจากหน่วยแรง  $\sigma_c$  กระทำที่เวลา  $t_0$  ถึงเวลา  $t$  คือผลรวมระหว่างการหดตัวเริ่มแรก และการหดตัวเชิงเวลา

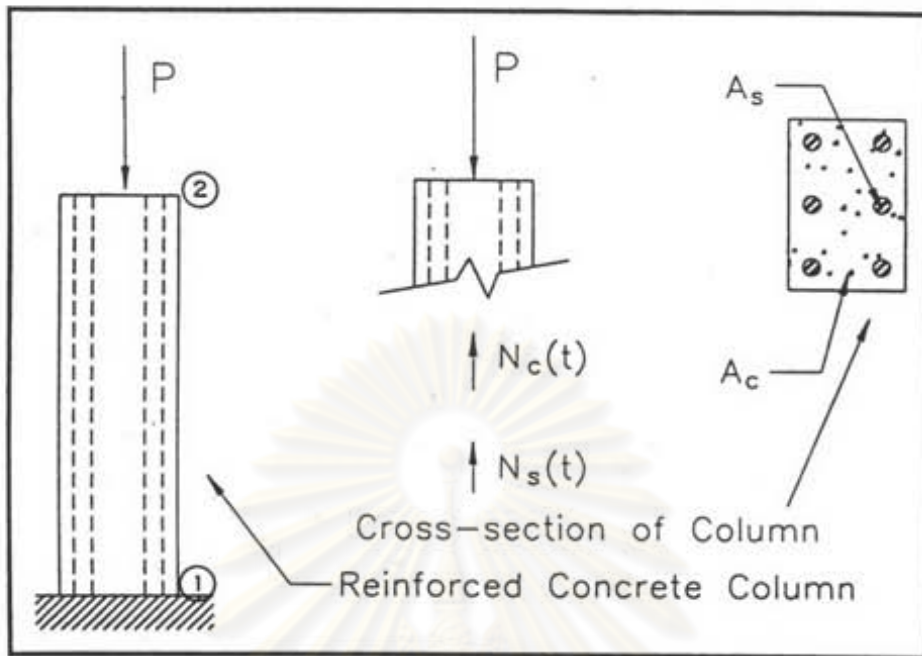
$$u_2(t, t_0) = u_2(t_0) + \Delta u_2(t, t_0) \quad (26)$$

เมื่อแทนค่าสมการที่ (23) และ (25) ลงในสมการที่ (26) (โดยจะกลับเครื่องหมายให้พิจารณาการหดตัว และแรงอัด (P) มีเครื่องหมายเป็นบวก) จะได้ว่า

$$\begin{aligned} u_2(t, t_0) &= \frac{PL}{E_c(t_0)A_c(1+n\rho)} + \frac{PL\phi(t, t_0)}{E_c(t_0)A_c(1+n\rho)} - \frac{PL\rho(n_e - n)(1 + \chi\phi(t, t_0))}{E_c(t_0)A_c(1+n\rho)(1+n_e'\rho)} \\ &\quad + \frac{\varepsilon_{sh}(t, t_0)L}{1+n_e'\rho} \\ &= \frac{PL(1 + \phi(t, t_0))}{E_c(t_0)A_c(1+n\rho)} + \frac{PL\rho(n - n_e)(1 + \chi\phi(t, t_0))}{E_c(t_0)A_c(1+n\rho)(1+n_e'\rho)} - \frac{\varepsilon_{sh}(t, t_0)Ln_e'\rho}{1+n_e'\rho} \\ &\quad + \varepsilon_{sh}(t, t_0)L \end{aligned} \quad (27)$$

เมื่อเปรียบเทียบสมการ (27) ที่ได้จากวิธีลดตีฟเนลโดยตรงจะเหมือนกับสมการที่วิเคราะห์ด้วยวิธีแรงโดย Beasley (1994) ในสมการที่ (15)

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



รูปที่ ข.1 เสาสั้นคอนกรีตเสริมเหล็กแบบสมมาตรรับน้ำหนัก  $P$  กระทำตามแนวแกน

ศูนย์วิทยทรัพยากร  
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ภาคผนวก ค

รายละเอียดข้อมูลและผลการวิเคราะห์ตัวอย่างที่ 1  
เสาคอนกรีตเสริมเหล็กรับน้ำหนักบรรทุกคงค้างคงที่ค่าเดียว



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

EXAMPLE (BY BEASLEY)

$$L = 5.00E+03 \text{ mm}$$

$$E_c(28) = 2.80E+04 \text{ MPa}$$

$$A_c = 9.00E+04 \text{ mm}^2$$

$$E_s = 2.00E+05 \text{ MPa}$$

$$A_s = 1.80E+03 \text{ mm}^2$$

$$\rho = 0.02$$

| TIME<br>(DAYS) | $E_c(t_i)$<br>(MPa) | n        | LOAD<br>N | TIME<br>(DAYS) | Creep Co. | Aging Co. |
|----------------|---------------------|----------|-----------|----------------|-----------|-----------|
| 10             | 25043.96            | 7.985957 | 2.00E+05  | (40,10)        | 1         | 0.97619   |
|                |                     |          |           | (70,10)        | 1.4       | 0.91111   |
|                |                     |          |           | (100,10)       | 1.8       | 0.82      |
|                |                     |          |           | (INF.,10)      | 3         | 0.8       |

COLUMN SHORTENING AT TIME : 10 DAYS TO INFINITY DAYS

| TIME( $t_i, t_n$ )<br>(DAYS) | $E_e(t_i, t_n)$<br>(MPa) | $\bar{E}_c(t_i, t_n)$<br>(MPa) | $ne_i$   | $ne_i'$  | Elastic<br>(mm.) | Creep<br>(mm.)    | SUM CRP.<br>(mm.) | TOTAL<br>(mm.) |
|------------------------------|--------------------------|--------------------------------|----------|----------|------------------|-------------------|-------------------|----------------|
| 10                           | 25043.96                 | 25043.96                       | 7.985957 | 7.985957 | 0.382562         | 0                 | 0                 | 0.382562       |
| 10 - 40                      | 12521.98                 | 12672.85                       | 15.97191 | 15.78177 |                  | 0.382562 -0.09178 | 0.290781          | 0.673343       |
| 10 - 70                      | 10434.98                 | 11005.65                       | 19.1663  | 18.17248 |                  | 0.535587 -0.14277 | 0.392817          | 0.775379       |
| 10 - 100                     | 8944.272                 | 10114.69                       | 22.36068 | 19.77323 |                  | 0.688611 -0.19515 | 0.493464          | 0.876026       |
| 10 - INF.                    | 6260.99                  | 7365.871                       | 31.94383 | 27.15225 |                  | 1.147686 -0.40391 | 0.74378           | 1.126341       |

THE STRESS OF CONCRETE AND STEEL AT TIME 10 TO INFINITY DAYS

| TIME<br>(DAYS) | CONCRETE (kg / mm <sup>2</sup> ) |          |          | STEEL (kg / mm <sup>2</sup> ) |          |
|----------------|----------------------------------|----------|----------|-------------------------------|----------|
|                | ELASTIC                          | CREEP    | SUM STR. | ELASTIC                       | STRESS   |
| 10             | 1.916173                         | 0        | 1.916173 | 15.30247                      | 15.30247 |
| 10 - 40        |                                  | -0.23262 | 1.683548 |                               | 26.93372 |
| 10 - 70        |                                  | -0.31425 | 1.601919 |                               | 31.01517 |
| 10 - 100       |                                  | -0.39477 | 1.521402 |                               | 35.04103 |
| 10 - INF.      |                                  | -0.59502 | 1.321149 |                               | 45.05366 |

FORCE IN CONCRETE AND STEEL AT TIME 10 TO INFINITY DAYS

| TIME      | P (N)  | CONC.(N) | STEEL(N) | TOTAL(N) |
|-----------|--------|----------|----------|----------|
| 10        | 200000 | 172455.5 | 27544.45 | 200000   |
| 10 - 40   | 200000 | 151519.3 | 48480.69 | 200000   |
| 10 - 70   | 200000 | 144172.7 | 55827.3  | 200000   |
| 10 - 100  | 200000 | 136926.2 | 63073.85 | 200000   |
| 10 - INF. | 200000 | 118903.4 | 81096.59 | 200000   |



<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : co1\_1

\*\*\* DATA \*\*\*

> CODE REFERENCE ..... : MANUAL  
 > NUMBER OF TOTAL NODES ..... : 4  
 > NUMBER OF TOTAL MEMBERS ..... : 3  
 > NUMBER OF TOTAL MATERIALS ..... : 1  
 > NUMBER OF TOTAL CONSTRUCTIONAL STAGES ..... : 1  
 > NUMBER OF BOUNDARY CONDITIONS ..... : 1  
 > DESTINATION TIME ..... : 20000 DAYS

COORDINAGE OF NODAL POINT

| Node | X-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 0.000        | 3000.000     |
| 3    | 0.000        | 4000.000     |
| 4    | 0.000        | 5000.000     |

Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 2      | 1         | 0              | YES      | NO       |
| 2    | 2      | 3      | 1         | 0              | YES      | NO       |
| 3    | 3      | 4      | 1         | 0              | YES      | NO       |

PROPERTY OF MATERIALS

| SET# MATERIALS | E          | A          | I          | G          | BETA       |
|----------------|------------|------------|------------|------------|------------|
| 1 CONCRETE     | 2.8000E+04 | 9.0000E+04 | 1.0000E+03 | 1.0000E+09 | 2.0000D+21 |
| STEEL          | 2.0000E+05 | 1.8000E+03 | 1.0000E+02 |            |            |

Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | X-Displ. | Y-Displ. | Z-Rotation |
|----------|----------|----------|------------|
| 1        | R        | R        | R          |

CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 3          | 10          | 1 2 3              |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
PROJECT : COLUMN DATE : 09-29-1995 FILE : co1\_1

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JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 1       | 4    | 0.000E+00 | -2.000E+05 | 0.000E+00 |



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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\col_1
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-----
=> COMBINATION MEMBER FORCES IN CONCRTE AND STEEL : INSTANTANBOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10 DAYS

```

| MEM. NODE | AXIAL(CONC)  | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |

```

-----
=> COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10 DAYS

```

| MEMBER | NODE | AXIAL        | SHBAR       | MOMENT      |
|--------|------|--------------|-------------|-------------|
| 1      | 1    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |
| 2      | 2    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |
| 3      | 3    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |
| 4      | 4    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |

```

-----
=> COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10 DAYS

```

| NODE | I-MOVEMENT  | Y-MOVEMENT    | ROTATION    |
|------|-------------|---------------|-------------|
| 1    | 0.00000D+00 | 0.00000D+00   | 0.00000D+00 |
| 2    | 0.00000D+00 | -2.295371D-01 | 0.00000D+00 |
| 3    | 0.00000D+00 | -3.060495D-01 | 0.00000D+00 |
| 4    | 0.00000D+00 | -3.825618D-01 | 0.00000D+00 |

```

-----
=> COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10 DAYS

```

| NODE | AXIAL FORCE  | SHBAR FORCE | BENDING MOMENT |
|------|--------------|-------------|----------------|
| 1    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00    |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUM  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\co1\_1

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.040057D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -5.386743D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -6.733429D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\COL\_1

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.652275D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -6.203033D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -7.753791D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUM  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\co1\_1

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -5.256154D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -7.008205D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -8.760256D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\COL\_1

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -6.758049D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -9.010731D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.126341D+00 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUM  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : COL\_2

\*\*\* DATA \*\*\*

> CODE REFERENCE ..... : MANUAL  
 > NUMBER OF TOTAL NODES ..... : 4  
 > NUMBER OF TOTAL MEMBERS ..... : 3  
 > NUMBER OF TOTAL MATERIALS ..... : 1  
 > NUMBER OF TOTAL CONSTRUCTIONAL STAGES .... : 4  
 > NUMBER OF BOUNDARY CONDITIONS ..... : 1  
 > DESTINATION TIME ..... : 20000 DAYS

COORDINAGE OF NODAL POINT

| Node | X-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 0.000        | 3000.000     |
| 3    | 0.000        | 4000.000     |
| 4    | 0.000        | 5000.000     |

Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 2      | 1         | 0              | YES      | NO       |
| 2    | 2      | 3      | 1         | 0              | YES      | NO       |
| 3    | 3      | 4      | 1         | 0              | YES      | NO       |

PROPERTY OF MATERIALS

| SET# | MATERIALS | E          | A          | I          | G          | BETA       |
|------|-----------|------------|------------|------------|------------|------------|
| 1    | CONCRETE  | 2.8000E+04 | 9.0000E+04 | 1.0000E+03 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0000E+05 | 1.8000E+03 | 1.0000E+02 |            |            |

Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | X-Disp. | Y-Disp. | Z-Rotation |
|----------|---------|---------|------------|
| 1        | R       | R       | R          |

CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 3          | 10          | 1 2 3              |
| 2      | 3          | 40          |                    |
| 3      | 3          | 70          |                    |
| 4      | 3          | 100         |                    |



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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
OFFICE : THESIS ENGINEER : SIRIPHAPHUN  
PROJECT : COLUMN DATE : 09-29-1995 FILE : COL\_2

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JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 1       | 4    | 0.000E+00 | -2.000E+05 | 0.000E+00 |



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\COL\_2

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 => COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| MEM. NODE | AXIAL(CONC)  | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |

=====  
 => COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| MEMBER | NODE | AXIAL        | SHBAR       | MOMENT      |
|--------|------|--------------|-------------|-------------|
| 1      | 1    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |
| 2      | 2    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |
| 3      | 3    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |
| 4      | 4    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00 |

=====  
 => COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| NODE | X-MOVEMENT  | Y-MOVEMENT    | ROTATION    |
|------|-------------|---------------|-------------|
| 1    | 0.00000D+00 | 0.00000D+00   | 0.00000D+00 |
| 2    | 0.00000D+00 | -2.295371D-01 | 0.00000D+00 |
| 3    | 0.00000D+00 | -3.060495D-01 | 0.00000D+00 |
| 4    | 0.00000D+00 | -3.825618D-01 | 0.00000D+00 |

=====  
 => COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| NODE | AXIAL FORCE  | SHBAR FORCE | BENDING MOMENT |
|------|--------------|-------------|----------------|
| 1    | -2.00000D+05 | 0.00000D+00 | 0.00000D+00    |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\COL\_2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.040057D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -5.386743D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -6.733429D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\COL\_2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 70 DAYS

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.43301D+05 | 0.00000D+00 | 0.00000D+00  | -5.66993D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.43301D+05 | 0.00000D+00 | 0.00000D+00  | -5.66993D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.43301D+05 | 0.00000D+00 | 0.00000D+00  | -5.66993D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.43301D+05 | 0.00000D+00 | 0.00000D+00  | -5.66993D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 70 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 70 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.724945D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -6.299927D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -7.874909D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 70 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS  
 PROJECT : COLUMN  
 ENGINEER : SIRIPHAPHUN  
 DATE : 09-29-1995 FILE : DATA\COL\_2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 100 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.35322D+05 | 0.00000D+00 | 0.00000D+00  | -6.46780D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.35322D+05 | 0.00000D+00 | 0.00000D+00  | -6.46780D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.35322D+05 | 0.00000D+00 | 0.00000D+00  | -6.46780D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.35322D+05 | 0.00000D+00 | 0.00000D+00  | -6.46780D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.35322D+05 | 0.00000D+00 | 0.00000D+00  | -6.46780D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.35322D+05 | 0.00000D+00 | 0.00000D+00  | -6.46780D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 100 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 100 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -5.389831D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -7.186441D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -8.983051D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 100 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUM  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\COL\_2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.12840D+05 | 0.00000D+00 | 0.00000D+00  | -8.71600D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.12840D+05 | 0.00000D+00 | 0.00000D+00  | -8.71600D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.12840D+05 | 0.00000D+00 | 0.00000D+00  | -8.71600D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.12840D+05 | 0.00000D+00 | 0.00000D+00  | -8.71600D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.12840D+05 | 0.00000D+00 | 0.00000D+00  | -8.71600D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.12840D+05 | 0.00000D+00 | 0.00000D+00  | -8.71600D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -7.263331D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -9.684441D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.210555D+00 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

ภาคผนวก ง

รายละเอียดข้อมูลและผลการวิเคราะห์ตัวอย่างที่ 2  
เสาคอนกรีตเสริมเหล็กรับน้ำหนักบรรทุกคงค้าง 4 ชั้นตอน



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## EXAMPLE 2 BY BEASLEY

$$\begin{aligned}
 L &= 5000 \text{ mm} & E_c(28) &= 28000 \text{ MPa} \\
 A_c &= 90000 \text{ mm}^2 & E_s &= 200000 \text{ MPa} \\
 A_s &= 1800 \text{ mm}^2 & \rho &= 0.02
 \end{aligned}$$

| TIME(t <sub>i</sub> )<br>(DAYS) | E <sub>c</sub> (t <sub>i</sub> )<br>(MPa) | n        | O(40,t <sub>i</sub> ) | O(70,t <sub>i</sub> ) | O(100,t <sub>i</sub> ) | O(inf,t <sub>i</sub> ) |
|---------------------------------|---|----------|-----------------------|-----------------------|------------------------|------------------------|
| 10                              | 25044                                     | 7.985945 | 1                     | 1.4                   | 1.8                    | 3                      |
| 40                              | 28727                                     | 6.962091 | 0                     | 0.4                   | 0.8                    | 2.1                    |
| 70                              | 29398                                     | 6.803184 | 0                     | 0                     | 0.4                    | 1.8                    |
| 100                             | 29680                                     | 6.738544 | 0                     | 0                     | 0                      | 1.6                    |

| TIME(t <sub>i</sub> )<br>(DAYS) | LOAD<br>(N) | X(40,t <sub>i</sub> ) | X(70,t <sub>i</sub> ) | X(100,t <sub>i</sub> ) | X(inf,t <sub>i</sub> ) |
|---------------------------------|-------------|-----------------------|-----------------------|------------------------|------------------------|
| 10                              | 200000      | 0.97619               | 0.91111               | 0.82                   | 0.8                    |
| 40                              | 250000      | 1                     | 0.93333               | 0.84                   | 0.8                    |
| 70                              | 300000      |                       | 1                     | 0.9                    | 0.8                    |
| 100                             | 250000      |                       |                       | 1                      | 0.8                    |

CONSIDER AT TIME t = 40 DAYS

SHRINKAGE STRAIN = 0.000205

| TIME(t <sub>i</sub> )<br>(DAYS) | E <sub>c</sub> (t <sub>i</sub> ,t <sub>n</sub> )<br>(MPa) | E <sub>c</sub> (t <sub>i</sub> ,t <sub>n</sub> )<br>(MPa) | n <sub>e</sub> | n <sub>e</sub> ' | ELASTIC<br>(mm) | CREEP<br>(mm)     | SHK.<br>(mm) | REINF.<br>(mm) | TOTAL<br>(mm) |
|---------------------------------|---|---|----------------|------------------|-----------------|-------------------|--------------|----------------|---------------|
| 10                              | 25044   | 25044   | 7.985945       | 7.985945         | 0.382561        | 0 0               |              |                |               |
| 10 - 40                         | 12522   | 12672.87  | 15.97189       | 15.78174         |                 | 0.382561 -0.09178 |              |                |               |
| 40                              | 28727   | 28727   | 6.962091       | 6.962091         | 0.424386        | 0 0               |              |                |               |
| SUM                             |   |   |                |                  | 0.806948        | 0.290781          | 1.025        | -0.24591       | 1.87682       |

STRESS AT TIME 10 TO 40 DAYS

| TIME(t <sub>i</sub> )<br>(DAYS) | ELASTIC<br>(MPa) | CREEP<br>(MPa) | SUM STR<br>(MPa) | SHK.<br>(MPa) | TOTAL<br>(MPa) | STEEL<br>(MPa) |
|---------------------------------|------------------|----------------|------------------|---------------|----------------|----------------|
| 10                              | 1.916173         | 0              | 1.916173         |               |                |                |
| 10 - 40                         |                  | -0.232625      | 1.683549         |               |                |                |
| 40                              | 2.438269         | 0              | 2.438269         |               |                |                |
| SUM                             |                  |                | 4.121817         | -0.62327      | 3.498544       | 75.0728        |



CONSIDER AT TIME  $t = 70$  DAYS

SHRINKAGE STRAIN = 0.00034

| TIME(t)<br>(DAYS) | $E_e(t_i, t_n)$<br>(MPa) | $E_c(t_i, t_n)$<br>(MPa) | $n_e$    | $n_e'$   | ELASTIC<br>(mm) | CREEP<br>(mm)     | SHK.<br>(mm) | REINF.<br>(mm) | TOTAL<br>(mm) |
|-------------------|--------------------------|--------------------------|----------|----------|-----------------|-------------------|--------------|----------------|---------------|
| 10                | 25044                    | 25044                    | 7.985945 | 7.985945 | 0.382561        | 0 0               |              |                |               |
| 10 - 40           | 10435                    | 11005.67                 | 19.16627 | 18.17245 |                 | 0.535586 -0.14277 |              |                |               |
| 40                | 28727                    | 28727                    | 6.962091 | 6.962091 | 0.424386        | 0 0               |              |                |               |
| 10 - 70           | 20519.29                 | 20917.74                 | 9.746928 | 9.561263 |                 | 0.169755 -0.02725 |              |                |               |
| 70                | 29398                    | 29398                    | 6.803184 | 6.803184 | 0.499032        | 0 0               |              |                |               |
| SUM               |                          |                          |          |          | 1.305979        | 0.535321          | 1.7          | -0.45316       | 3.088139      |

STRESS AT TIME 10 TO 70 DAYS

| TIME(t)<br>(DAYS) | ELASTIC<br>(MPa) | CREEP<br>(MPa) | SUM STR<br>(MPa) | SHK.<br>(MPa) | TOTAL<br>(MPa) | STEEL<br>(MPa) |
|-------------------|------------------|----------------|------------------|---------------|----------------|----------------|
| 10                | 1.916173         | 0              | 1.916173         |               |                |                |
| 10 - 40           |                  | -0.314254      | 1.60192          |               |                |                |
| 40                | 2.438269         | 0              | 2.438269         |               |                |                |
| 40 - 70           |                  | -0.114003      | 2.324265         |               |                |                |
| 70                | 2.934108         | 0              | 2.934108         |               |                |                |
| SUM               |                  |                | 6.860293         | -0.99747      | 5.862823       | 123.5255       |

CONSIDER AT TIME  $t = 100$  DAYS

SHRINKAGE STRAIN = 0.0004

| TIME(t)<br>(DAYS) | $E_e(t_i, t_n)$<br>(MPa) | $E_c(t_i, t_n)$<br>(MPa) | $n_e$    | $n_e'$   | ELASTIC<br>(mm) | CREEP<br>(mm)     | SHK.<br>(mm) | REINF.<br>(mm) | TOTAL<br>(mm) |
|-------------------|--------------------------|--------------------------|----------|----------|-----------------|-------------------|--------------|----------------|---------------|
| 10                | 25044                    | 25044                    | 7.985945 | 7.985945 | 0.382561        | 0 0               |              |                |               |
| 10 - 40           | 8944.286                 | 10114.7                  | 22.36065 | 19.7732  |                 | 0.68861 -0.19515  |              |                |               |
| 40                | 28727                    | 28727                    | 6.962091 | 6.962091 | 0.424386        | 0 0               |              |                |               |
| 40 - 70           | 15959.44                 | 17181.22                 | 12.53176 | 11.64062 |                 | 0.339509 -0.06412 |              |                |               |
| 70                | 29398                    | 29398                    | 6.803184 | 6.803184 | 0.499032        | 0 0               |              |                |               |
| 70 - 100          | 20998.57                 | 21616.18                 | 9.524457 | 9.25233  |                 | 0.199613 -0.03117 |              |                |               |
| 100               | 29680                    | 29680                    | 6.738544 | 6.738544 | 0.412378        | 0 0               |              |                |               |
| SUM               |                          |                          |          |          | 1.718357        | 0.9373            | 2            | -0.56678       | 4.088873      |

## STRESS AT TIME 10 TO 100 DAYS

| TIME(t)<br>(DAYS) | ELASTIC<br>(MPa) | CREEP<br>(MPa) | SUM STR<br>(MPa) | SHK.<br>(MPa) | TOTAL<br>(MPa) | STEEL<br>(MPa) |
|-------------------|------------------|----------------|------------------|---------------|----------------|----------------|
| 10                | 1.916173         | 0              | 1.916173         |               |                |                |
| 10 - 40           |                  | -0.394771      | 1.521402         |               |                |                |
| 40                | 2.438269         | 0              | 2.438269         |               |                |                |
| 10 - 70           |                  | -0.220315      | 2.217954         |               |                |                |
| 70                | 2.934108         | 0              | 2.934108         |               |                |                |
| 10 - 100          |                  | -0.134754      | 2.799353         |               |                |                |
| 100               | 2.447875         | 0              | 2.447875         |               |                |                |
| SUM               |                  |                | 8.986585         | -1.14657      | 7.840013       | 163.5549       |

## CONSIDER AT TIME 10 TO INFINITY DAYS

SHRINKAGE STRAIN = 0.0006

| TIME(t)<br>(DAYS) | E <sub>e</sub> (t,t <sub>n</sub> )<br>(MPa) | E <sub>c</sub> (t,t <sub>n</sub> )<br>(MPa) | n <sub>c</sub> | n <sub>e</sub> ' | ELASTIC<br>(mm) | CREEP<br>(mm)     | SHK.<br>(mm) | REINF.<br>(mm) | TOTAL<br>(mm) |
|-------------------|---|---|----------------|------------------|-----------------|-------------------|--------------|----------------|---------------|
| 10                | 25044                                       | 25044                                       | 7.985945       | 7.985945         | 0.382561        | 0 0               |              |                |               |
| 10 - 40           | 6261  | 7365.882                                    | 31.94378       | 27.15221         |                 | 1.147684 -0.4039  |              |                |               |
| 40                | 28727                                       | 28727                                       | 6.962091       | 6.962091         | 0.424386        | 0 0               |              |                |               |
| 10 - 70           | 9266.774                                    | 10719.03                                    | 21.58248       | 18.6584          |                 | 0.891211 -0.24219 |              |                |               |
| 70                | 29398                                       | 29398                                       | 6.803184       | 6.803184         | 0.499032        | 0 0               |              |                |               |
| 10 - 100          | 10499.29                                    | 12048.36                                    | 19.04891       | 16.59977         |                 | 0.898257 -0.22389 |              |                |               |
| 100               | 29680                                       | 29680                                       | 6.738544       | 6.738544         | 0.412378        | 0 0               |              |                |               |
| 10 - INF.         | 11415.38                                    | 13017.54                                    | 17.52022       | 15.36388         |                 | 0.659805 -0.15509 |              |                |               |
| SUM               |   |   |                |                  | 1.718357        | 2.571884          | 3            | -1.05579       | 6.23445       |

## STRESS AT TIME 10 TO INFINITY DAYS

| TIME(t)<br>(DAYS) | ELASTIC<br>(MPa) | CREEP<br>(MPa) | SUM STR<br>(MPa) | SHK.<br>(MPa) | TOTAL<br>(MPa) | STEEL<br>(MPa) |
|-------------------|------------------|----------------|------------------|---------------|----------------|----------------|
| 10                | 1.916173         | 0              | 1.916173         |               |                |                |
| 10 - 40           |                  | -0.595023      | 1.32115          |               |                |                |
| 40                | 2.438269         | 0              | 2.438269         |               |                |                |
| 10 - 70           |                  | -0.519215      | 1.919054         |               |                |                |
| 70                | 2.934108         | 0              | 2.934108         |               |                |                |
| 10 - 100          |                  | -0.539496      | 2.394612         |               |                |                |
| 100               | 2.447875         | 0              | 2.447875         |               |                |                |
| 10 - INF.         |                  | -0.403773      | 2.044102         |               |                |                |
| SUM               |                  |                | 7.678918         | -1.55537      | 6.123551       | 249.378        |

## SUMMARY CONCRETE STRESS AT TIME 10 TO INFINITY DAYS

| TIME(t)<br>(DAYS) | P<br>(N) | ELASTIC<br>(MPa) | STRESS INCREASING<br>(MPa) |          | TOTAL<br>(MPa) |
|-------------------|----------|------------------|----------------------------|----------|----------------|
| 10                | 200000   | 1.916173         | 1.916173                   |          | 1.916173       |
| 40                | 250000   | 2.438269         | 1.060275                   | 2.438269 | 3.498544       |
| 70                | 300000   | 2.934108         | 2.928715                   | 2.934108 | 5.862823       |
| 100               | 250000   | 2.447875         | 5.392138                   | 2.447875 | 7.840013       |
| INFINITY          |          |                  | 6.123551                   |          | 6.123551       |

## SUMMARY STEEL STRESS AT TIME 10 TO INFINITY DAYS

| TIME(t)<br>(DAYS) | P<br>(N) | ELASTIC<br>(MPa) | STRESS INCREASING<br>(MPa) |          | TOTAL<br>(MPa) |
|-------------------|----------|------------------|----------------------------|----------|----------------|
| 10                | 200000   | 15.30245         | 15.30245                   |          | 15.30245       |
| 40                | 250000   | 16.97545         | 58.09735                   | 16.97545 | 75.0728        |
| 70                | 300000   | 19.96128         | 103.5643                   | 19.96128 | 123.5255       |
| 100               | 250000   | 16.49512         | 147.0598                   | 16.49512 | 163.5549       |
| INFINITY          |          |                  | 249.378                    |          | 249.378        |

## FORCE IN CONCRETE AND STEEL AT TIME 10 TO INFINITY DAYS

| TIME(t)<br>(DAYS) | P<br>(N) | CONC.<br>(N) | STEEL<br>(N) | TOTAL<br>(N) |
|-------------------|----------|--------------|--------------|--------------|
| 10                | 200000   | 172455.6     | 27544.42     | 200000       |
| 10 - 40           | 200000   | 95424.78     | 104575.2     | 200000       |
| 40                | 250000   | 219444.2     | 30555.81     | 250000       |
| 10 - 70           | 450000   | 263584.3     | 186415.7     | 450000       |
| 70                | 300000   | 264069.7     | 35930.3      | 300000       |
| 10 - 100          | 750000   | 485292.4     | 264707.6     | 750000       |
| 100               | 250000   | 220308.8     | 29691.21     | 250000       |
| 10 - INF.         | 1000000  | 551119.6     | 448880.4     | 1000000      |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : column2

\*\*\* DATA \*\*\*

> CODE REFERENCE ..... : MANUAL  
 > NUMBER OF TOTAL NODES ..... : 4  
 > NUMBER OF TOTAL MEMBERS ..... : 3  
 > NUMBER OF TOTAL MATERIALS ..... : 1  
 > NUMBER OF TOTAL CONSTRUCTIONAL STAGES .... : 4  
 > NUMBER OF BOUNDARY CONDITIONS ..... : 1  
 > DESTINATION TIME ..... : 20000 DAYS

COORDINAGE OF NODAL POINT

| Node | X-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 0.000        | 3000.000     |
| 3    | 0.000        | 4000.000     |
| 4    | 0.000        | 5000.000     |

Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 2      | 1         | 0              | YES      | NO       |
| 2    | 2      | 3      | 1         | 0              | YES      | NO       |
| 3    | 3      | 4      | 1         | 0              | YES      | NO       |

PROPERTY OF MATERIALS

| SET# MATERIALS | E          | A          | I          | G          | BETA       |
|----------------|------------|------------|------------|------------|------------|
| 1 CONCRETE     | 2.8000E+04 | 9.0000E+04 | 1.0000E+03 | 1.0000E+09 | 2.0000E+21 |
| STEEL          | 2.0000E+05 | 1.8000E+03 | 1.0000E+02 |            |            |

Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | X-Disp. | Y-Disp. | Z-Rotation |
|----------|---------|---------|------------|
| 1        | R       | R       | R          |

CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 3          | 10          | 1 2 3              |
| 2      | 3          | 40          |                    |
| 3      | 3          | 70          |                    |
| 4      | 3          | 100         |                    |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : column2

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 1       | 4    | 0.000E+00 | -2.000E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 2       | 4    | 0.000E+00 | -2.500E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 3       | 4    | 0.000E+00 | -3.000E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 4       | 4    | 0.000E+00 | -2.500E+05 | 0.000E+00 |

ศูนย์วิทยทรัพยากร  
 จุฬาลงกรณ์มหาวิทยาลัย

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS ENGINEER : SIRIPHARPHUM
PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column2

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

```

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 1       | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 2       | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 3       | -1.51519D+05 | 0.00000D+00 | 0.00000D+00  | -4.84807D+04 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.040057D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -5.386743D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -6.733429D-01 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 40 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

```

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 1       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 2       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 3       | -1.44173D+05 | 0.00000D+00 | 0.00000D+00  | -5.58273D+04 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.652275D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -6.203033D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -7.753791D-01 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -2.09184D+05 | 0.00000D+00 | 0.00000D+00  | -4.08156D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -2.09184D+05 | 0.00000D+00 | 0.00000D+00  | -4.08156D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -2.09184D+05 | 0.00000D+00 | 0.00000D+00  | -4.08156D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -2.09184D+05 | 0.00000D+00 | 0.00000D+00  | -4.08156D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -3.401303D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -4.535071D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -5.668839D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 70 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00   |



```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUM
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

```

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.36926D+05 | 0.00000D+00 | 0.00000D+00  | -6.30738D+04 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -5.256154D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -7.008205D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -8.760256D-01 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.99616D+05 | 0.00000D+00 | 0.00000D+00  | -5.03836D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.99616D+05 | 0.00000D+00 | 0.00000D+00  | -5.03836D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.99616D+05 | 0.00000D+00 | 0.00000D+00  | -5.03836D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.99616D+05 | 0.00000D+00 | 0.00000D+00  | -5.03836D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.198635D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -5.598180D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -6.997725D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -2.51942D+05 | 0.00000D+00 | 0.00000D+00  | -4.80580D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -2.51942D+05 | 0.00000D+00 | 0.00000D+00  | -4.80580D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -2.51942D+05 | 0.00000D+00 | 0.00000D+00  | -4.80580D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -2.51942D+05 | 0.00000D+00 | 0.00000D+00  | -4.80580D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -2.51942D+05 | 0.00000D+00 | 0.00000D+00  | -4.80580D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -2.51942D+05 | 0.00000D+00 | 0.00000D+00  | -4.80580D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.004830D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -5.339774D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -6.674718D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 100 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| MEM. NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 1 2       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 3       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 4       | -1.18903D+05 | 0.00000D+00 | 0.00000D+00  | -8.10966D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 1      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -6.758049D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -9.010731D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.126341D+00 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2
  
```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS
  
```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.72716D+05 | 0.00000D+00 | 0.00000D+00  | -7.72844D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.72716D+05 | 0.00000D+00 | 0.00000D+00  | -7.72844D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.72716D+05 | 0.00000D+00 | 0.00000D+00  | -7.72844D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.72716D+05 | 0.00000D+00 | 0.00000D+00  | -7.72844D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.72716D+05 | 0.00000D+00 | 0.00000D+00  | -7.72844D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.72716D+05 | 0.00000D+00 | 0.00000D+00  | -7.72844D+04 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS
  
```

| MEMBER | NODE | AXIAL        | SHEAR       | MOMENT      |
|--------|------|--------------|-------------|-------------|
| 1      | 1    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00 |
|        | 2    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00 |
| 2      | 2    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00 |
|        | 3    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00 |
| 3      | 3    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00 |
|        | 4    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS
  
```

| NODE | X-MOVEMENT  | Y-MOVEMENT    | ROTATION    |
|------|-------------|---------------|-------------|
| 1    | 0.00000D+00 | 0.00000D+00   | 0.00000D+00 |
| 2    | 0.00000D+00 | -6.440384D-01 | 0.00000D+00 |
| 3    | 0.00000D+00 | -8.587152D-01 | 0.00000D+00 |
| 4    | 0.00000D+00 | -1.073394D+00 | 0.00000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS
  
```

| NODE | AXIAL FORCE  | SHEAR FORCE | BENDING MOMENT |
|------|--------------|-------------|----------------|
| 1    | -2.50000D+05 | 0.00000D+00 | 0.00000D+00    |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -2.15515D+05 | 0.00000D+00 | 0.00000D+00  | -8.44846D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -2.15515D+05 | 0.00000D+00 | 0.00000D+00  | -8.44846D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -2.15515D+05 | 0.00000D+00 | 0.00000D+00  | -8.44846D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -2.15515D+05 | 0.00000D+00 | 0.00000D+00  | -8.44846D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -2.15515D+05 | 0.00000D+00 | 0.00000D+00  | -8.44846D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -2.15515D+05 | 0.00000D+00 | 0.00000D+00  | -8.44846D+04 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -7.040381D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -9.387175D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.173397D+00 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -3.000000D+05 | 0.000000D+00 | 0.000000D+00   |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUM
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -1.83969D+05 | 0.00000D+00 | 0.00000D+00  | -6.60309D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -1.83969D+05 | 0.00000D+00 | 0.00000D+00  | -6.60309D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -1.83969D+05 | 0.00000D+00 | 0.00000D+00  | -6.60309D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -1.83969D+05 | 0.00000D+00 | 0.00000D+00  | -6.60309D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -1.83969D+05 | 0.00000D+00 | 0.00000D+00  | -6.60309D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -1.83969D+05 | 0.00000D+00 | 0.00000D+00  | -6.60309D+04 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -5.502575D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -7.336767D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -9.170959D-01 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 20000 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.500000D+05 | 0.000000D+00 | 0.000000D+00   |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995    FILE : column

```

\*\*\* DATA \*\*\*

```

> CODE REFERENCE ..... : MANUAL
> NUMBER OF TOTAL NODES ..... : 4
> NUMBER OF TOTAL MEMBERS ..... : 3
> NUMBER OF TOTAL MATERIALS ..... : 1
> NUMBER OF TOTAL CONSTRUCTIONAL STAGES .... : 4
> NUMBER OF BOUNDARY CONDITIONS ..... : 1
> DESTINATION TIME ..... : 20000 DAYS

```

COORDINAGE OF NODAL POINT

| Node | X-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 0.000        | 3000.000     |
| 3    | 0.000        | 4000.000     |
| 4    | 0.000        | 5000.000     |

Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 2      | 1         | 0              | YES      | NO       |
| 2    | 2      | 3      | 1         | 0              | YES      | NO       |
| 3    | 3      | 4      | 1         | 0              | YES      | NO       |

PROPERTY OF MATERIALS

| SET# MATERIALS | E          | A          | I          | G          | BETA       |
|----------------|------------|------------|------------|------------|------------|
| 1 CONCRETE     | 2.8000E+04 | 9.0000E+04 | 1.0000E+03 | 1.0000E+09 | 2.0000D+21 |
| STEEL          | 2.0000E+05 | 1.8000E+03 | 1.0000E+02 |            |            |

Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | X-Displ. | Y-Displ. | Z-Rotation |
|----------|----------|----------|------------|
| 1        | R        | R        | R          |

CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 3          | 10          | 1 2 3              |
| 2      | 3          | 40          |                    |
| 3      | 3          | 70          |                    |
| 4      | 3          | 100         |                    |



---

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : column

---

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 1       | 4    | 0.000E+00 | -2.000E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 2       | 4    | 0.000E+00 | -2.500E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 3       | 4    | 0.000E+00 | -3.000E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 4       | 4    | 0.000E+00 | -2.500E+05 | 0.000E+00 |



ศูนย์วิทยทรัพยากร  
 จุฬาลงกรณ์มหาวิทยาลัย

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| MEM. NODE | AXIAL(CONC)  | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|-----------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | -1.72456D+05 | 0.00000D+00 | 0.00000D+00  | -2.75445D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| MEMBER | NODE | AXIAL         | SHBAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| NODE | I-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -2.295371D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -3.060495D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -3.825618D-01 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT  
 => AT SBQUENCB 1 TO 1 : END OF TIME 10 DAYS

| NODE | AXIAL FORCE   | SHBAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -2.000000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 40 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -3.52024D+05 | 0.00000D+00 | 0.00000D+00  | -9.79756D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -3.52024D+05 | 0.00000D+00 | 0.00000D+00  | -9.79756D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -3.52024D+05 | 0.00000D+00 | 0.00000D+00  | -9.79756D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -3.52024D+05 | 0.00000D+00 | 0.00000D+00  | -9.79756D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -3.52024D+05 | 0.00000D+00 | 0.00000D+00  | -9.79756D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -3.52024D+05 | 0.00000D+00 | 0.00000D+00  | -9.79756D+04 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 40 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 40 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -6.586344D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -8.781792D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.097724D+00 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 2 : END OF TIME 40 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -4.500000D+05 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THESIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 70 DAYS

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -5.84812D+05 | 0.00000D+00 | 0.00000D+00  | -1.65188D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -5.84812D+05 | 0.00000D+00 | 0.00000D+00  | -1.65188D+05 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -5.84812D+05 | 0.00000D+00 | 0.00000D+00  | -1.65188D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -5.84812D+05 | 0.00000D+00 | 0.00000D+00  | -1.65188D+05 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -5.84812D+05 | 0.00000D+00 | 0.00000D+00  | -1.65188D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -5.84812D+05 | 0.00000D+00 | 0.00000D+00  | -1.65188D+05 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 70 DAYS

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 70 DAYS

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -1.115881D+00 | 0.000000D+00 |
| 3    | 0.000000D+00 | -1.487841D+00 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.859801D+00 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT  
 => AT SEQUENCE 1 TO 3 : END OF TIME 70 DAYS

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -7.500000D+05 | 0.000000D+00 | 0.000000D+00   |

```

=====
<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUM
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column
=====

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 100 DAYS

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -7.05156D+05 | 0.00000D+00 | 0.00000D+00  | -2.94844D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -7.05156D+05 | 0.00000D+00 | 0.00000D+00  | -2.94844D+05 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -7.05156D+05 | 0.00000D+00 | 0.00000D+00  | -2.94844D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -7.05156D+05 | 0.00000D+00 | 0.00000D+00  | -2.94844D+05 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -7.05156D+05 | 0.00000D+00 | 0.00000D+00  | -2.94844D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -7.05156D+05 | 0.00000D+00 | 0.00000D+00  | -2.94844D+05 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 100 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 100 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -1.623991D+00 | 0.000000D+00 |
| 3    | 0.000000D+00 | -2.165321D+00 | 0.000000D+00 |
| 4    | 0.000000D+00 | -2.706651D+00 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 100 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00   |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS
PROJECT : COLUMN
ENGINEER : SIRIPHARPHUN
DATE : 09-29-1995 FILE : DATA\column

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | -6.72369D+05 | 0.00000D+00 | 0.00000D+00  | -3.27631D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | -6.72369D+05 | 0.00000D+00 | 0.00000D+00  | -3.27631D+05 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | -6.72369D+05 | 0.00000D+00 | 0.00000D+00  | -3.27631D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | -6.72369D+05 | 0.00000D+00 | 0.00000D+00  | -3.27631D+05 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | -6.72369D+05 | 0.00000D+00 | 0.00000D+00  | -3.27631D+05 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | -6.72369D+05 | 0.00000D+00 | 0.00000D+00  | -3.27631D+05 | 0.00000D+00  | 0.00000D+00   |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

```

| MEMBER | NODE | AXIAL         | SHEAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |
|        | 4    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00 |

```

=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -2.730255D+00 | 0.000000D+00 |
| 3    | 0.000000D+00 | -3.640339D+00 | 0.000000D+00 |
| 4    | 0.000000D+00 | -4.550424D+00 | 0.000000D+00 |

```

=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 4 : END OF TIME 20000 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -1.000000D+06 | 0.000000D+00 | 0.000000D+00   |

```

=====
<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRBTE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : column2
=====

```

\*\*\* DATA \*\*\*

```

> CODE REFERENCE ..... : MANUAL
> NUMBER OF TOTAL NODBS ..... : 4
> NUMBER OF TOTAL MEMBERS ..... : 3
> NUMBER OF TOTAL MATERIALS ..... : 1
> NUMBER OF TOTAL CONSTRUCTIONAL STAGES ..... : 1
> NUMBER OF BOUNDARY CONDITIONS ..... : 1
> DESTINATION TIME ..... : 20000 DAYS

```

COORDINAGE OF NODAL POINT

| Node | I-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 0.000        | 3000.000     |
| 3    | 0.000        | 4000.000     |
| 4    | 0.000        | 5000.000     |

Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 2      | 1         | 0              | YES      | YES      |
| 2    | 2      | 3      | 1         | 0              | YES      | YES      |
| 3    | 3      | 4      | 1         | 0              | YES      | YES      |

PROPERTY OF MATERIALS

| SBT# MATERIALS | B          | A          | I          | G          | BETA       |
|----------------|------------|------------|------------|------------|------------|
| 1 CONCRETE     | 2.8000E+04 | 9.0000E+04 | 1.0000E+03 | 1.0000E+09 | 2.0000E+21 |
| STEEL          | 2.0000E+05 | 1.8000E+03 | 1.0000E+02 |            |            |

Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | I-Displ. | Y-Displ. | Z-Rotation |
|----------|----------|----------|------------|
| 1        | R        | R        | R          |

CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 3          | 10          | 1 2 3              |

```

=====
<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2
=====

```

```

-----
=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQURNCB 1 TO 1 : END OF TIME 40 DAYS

```

| MEM. | NODE | AXIAL(CONC) | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|------|------|-------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | 5.60946D+04 | 0.00000D+00 | 0.00000D+00  | -5.60946D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 2    | 5.60946D+04 | 0.00000D+00 | 0.00000D+00  | -5.60946D+04 | 0.00000D+00  | 0.00000D+00   |
| 2    | 2    | 5.60946D+04 | 0.00000D+00 | 0.00000D+00  | -5.60946D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 3    | 5.60946D+04 | 0.00000D+00 | 0.00000D+00  | -5.60946D+04 | 0.00000D+00  | 0.00000D+00   |
| 3    | 3    | 5.60946D+04 | 0.00000D+00 | 0.00000D+00  | -5.60946D+04 | 0.00000D+00  | 0.00000D+00   |
|      | 4    | 5.60946D+04 | 0.00000D+00 | 0.00000D+00  | -5.60946D+04 | 0.00000D+00  | 0.00000D+00   |

```

-----
=> COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQURNCB 1 TO 1 : END OF TIME 40 DAYS

```

| MEMBER | NODE | AXIAL         | SHBAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -5.165646D-11 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -5.165646D-11 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -1.014087D-10 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -1.014087D-10 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | 3.547029D-11  | 0.000000D+00 | 0.000000D+00 |
|        | 4    | 3.547029D-11  | 0.000000D+00 | 0.000000D+00 |

```

-----
=> COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQURNCB 1 TO 1 : END OF TIME 40 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -4.674548D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -6.232730D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -7.790912D-01 | 0.000000D+00 |

```

-----
=> COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT
=> AT SBQURNCB 1 TO 1 : END OF TIME 40 DAYS

```

| NODE | AXIAL FORCE   | SHBAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -5.165646D-11 | 0.000000D+00 | 0.000000D+00   |



```

=====
<< THRSIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THRSIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2
=====

```

```

-----
=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQUNCE 1 TO 1 : END OF TIME 70 DAYS

```

| MEM. NODE | AXIAL(CONC) | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|-----------|-------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | 8.97723D+04 | 0.00000D+00 | 0.00000D+00  | -8.97723D+04 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | 8.97723D+04 | 0.00000D+00 | 0.00000D+00  | -8.97723D+04 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | 8.97723D+04 | 0.00000D+00 | 0.00000D+00  | -8.97723D+04 | 0.00000D+00  | 0.00000D+00   |
| 4 4       | 8.97723D+04 | 0.00000D+00 | 0.00000D+00  | -8.97723D+04 | 0.00000D+00  | 0.00000D+00   |

```

-----
=> COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQUNCE 1 TO 1 : END OF TIME 70 DAYS

```

| MEMBER | NODE | AXIAL         | SHBAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -1.001865D-10 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -1.001865D-10 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | -5.456968D-12 | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | -5.456968D-12 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | 2.067964D-10  | 0.000000D+00 | 0.000000D+00 |
| 4      | 4    | 2.067964D-10  | 0.000000D+00 | 0.000000D+00 |

```

-----
=> COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQUNCE 1 TO 1 : END OF TIME 70 DAYS

```

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -7.481025D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -9.974700D-01 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.246837D+00 | 0.000000D+00 |

```

-----
=> COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT
=> AT SBQUNCE 1 TO 1 : END OF TIME 70 DAYS

```

| NODE | AXIAL FORCE   | SHBAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -1.001865D-10 | 0.000000D+00 | 0.000000D+00   |

```

=====
<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : THESIS                               ENGINEER : SIRIPHARPHUN
PROJECT : COLUMN                               DATE : 09-29-1995   FILE : DATA\column2
=====

```

```

-----
=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQUENCB 1 TO 1 : END OF TIME 100 DAYS

```

| MEM. NODE | AXIAL(CONC) | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|-----------|-------------|-------------|--------------|--------------|--------------|---------------|
| 1 1       | 1.03191D+05 | 0.00000D+00 | 0.00000D+00  | -1.03191D+05 | 0.00000D+00  | 0.00000D+00   |
| 1 2       | 1.03191D+05 | 0.00000D+00 | 0.00000D+00  | -1.03191D+05 | 0.00000D+00  | 0.00000D+00   |
| 2 2       | 1.03191D+05 | 0.00000D+00 | 0.00000D+00  | -1.03191D+05 | 0.00000D+00  | 0.00000D+00   |
| 2 3       | 1.03191D+05 | 0.00000D+00 | 0.00000D+00  | -1.03191D+05 | 0.00000D+00  | 0.00000D+00   |
| 3 3       | 1.03191D+05 | 0.00000D+00 | 0.00000D+00  | -1.03191D+05 | 0.00000D+00  | 0.00000D+00   |
| 3 4       | 1.03191D+05 | 0.00000D+00 | 0.00000D+00  | -1.03191D+05 | 0.00000D+00  | 0.00000D+00   |

```

-----
=> COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQUENCB 1 TO 1 : END OF TIME 100 DAYS

```

| MEMBER | NODE | AXIAL         | SHBAR        | MOMENT       |
|--------|------|---------------|--------------|--------------|
| 1      | 1    | -9.660539D-11 | 0.000000D+00 | 0.000000D+00 |
|        | 2    | -9.660539D-11 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2    | -1.535909D-10 | 0.000000D+00 | 0.000000D+00 |
|        | 3    | -1.535909D-10 | 0.000000D+00 | 0.000000D+00 |
| 3      | 3    | 1.236913D-10  | 0.000000D+00 | 0.000000D+00 |
|        | 4    | 1.236913D-10  | 0.000000D+00 | 0.000000D+00 |

```

-----
=> COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT
=> AT SBQUENCB 1 TO 1 : END OF TIME 100 DAYS

```

| NODE | I-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -8.599286D-01 | 0.000000D+00 |
| 3    | 0.000000D+00 | -1.146571D+00 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.433214D+00 | 0.000000D+00 |

```

-----
=> COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT
=> AT SBQUENCB 1 TO 1 : END OF TIME 100 DAYS

```

| NODE | AXIAL FORCE   | SHBAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -9.660539D-11 | 0.000000D+00 | 0.000000D+00   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : THBSIS ENGINEER : SIRIPHARPHUN  
 PROJECT : COLUMN DATE : 09-29-1995 FILE : DATA\column2

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUNCE 1 TO 1 : END OF TIME 20000 DAYS

| MEM. NO | NO | AXIAL(CONC) | SHBAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHBAR(STEEL) | MOMENT(STEEL) |
|---------|----|-------------|-------------|--------------|--------------|--------------|---------------|
| 1       | 1  | 1.39983D+05 | 0.00000D+00 | 0.00000D+00  | -1.39983D+05 | 0.00000D+00  | 0.00000D+00   |
|         | 2  | 1.39983D+05 | 0.00000D+00 | 0.00000D+00  | -1.39983D+05 | 0.00000D+00  | 0.00000D+00   |
| 2       | 2  | 1.39983D+05 | 0.00000D+00 | 0.00000D+00  | -1.39983D+05 | 0.00000D+00  | 0.00000D+00   |
|         | 3  | 1.39983D+05 | 0.00000D+00 | 0.00000D+00  | -1.39983D+05 | 0.00000D+00  | 0.00000D+00   |
| 3       | 3  | 1.39983D+05 | 0.00000D+00 | 0.00000D+00  | -1.39983D+05 | 0.00000D+00  | 0.00000D+00   |
|         | 4  | 1.39983D+05 | 0.00000D+00 | 0.00000D+00  | -1.39983D+05 | 0.00000D+00  | 0.00000D+00   |

=> COMBINATION MEMBER FORCES : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUNCE 1 TO 1 : END OF TIME 20000 DAYS

| MEMBER | NO | AXIAL         | SHBAR        | MOMENT       |
|--------|----|---------------|--------------|--------------|
| 1      | 1  | -1.321325D-10 | 0.000000D+00 | 0.000000D+00 |
|        | 2  | -1.321325D-10 | 0.000000D+00 | 0.000000D+00 |
| 2      | 2  | 1.284661D-11  | 0.000000D+00 | 0.000000D+00 |
|        | 3  | 1.284661D-11  | 0.000000D+00 | 0.000000D+00 |
| 3      | 3  | -1.599574D-10 | 0.000000D+00 | 0.000000D+00 |
|        | 4  | -1.599574D-10 | 0.000000D+00 | 0.000000D+00 |

=> COMBINATION JOINT DISPLACEMENT : INSTANTANBOUS + TIME DEPENDENT  
 => AT SBQUNCE 1 TO 1 : END OF TIME 20000 DAYS

| NODE | I-MOVEMENT   | Y-MOVEMENT    | ROTATION     |
|------|--------------|---------------|--------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00 |
| 2    | 0.000000D+00 | -1.166525D+00 | 0.000000D+00 |
| 3    | 0.000000D+00 | -1.555366D+00 | 0.000000D+00 |
| 4    | 0.000000D+00 | -1.944208D+00 | 0.000000D+00 |

=> COMBINATION REACTION OF SUPPORTS : INSTANTANBOUS & TIME DEPENDENT  
 => AT SBQUNCE 1 TO 1 : END OF TIME 20000 DAYS

| NODE | AXIAL FORCE   | SHBAR FORCE  | BENDING MOMENT |
|------|---------------|--------------|----------------|
| 1    | -1.321325D-10 | 0.000000D+00 | 0.000000D+00   |

ภาคผนวก ๑

รายละเอียดข้อมูลและผลการวิเคราะห์ตัวอย่างที่ 3  
โครงข้อแข็งพอร์ทอล (Portal frame) 1 ชั้น



ศูนย์วิจัยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : EXAMPLE2 ENGINEER : SIRIPHARPHUN
PROJECT : EXAMPLE2 DATE : 08-31-1996 FILE : EXAMPLE4

```

### \*\*\* DATA \*\*\*

```

> CODE REFERENCE ..... : MANUAL
> NUMBER OF TOTAL NODES ..... : 4
> NUMBER OF TOTAL MEMBERS ..... : 3
> NUMBER OF TOTAL MATERIALS ..... : 2
> NUMBER OF TOTAL CONSTRUCTIONAL STAGES .... : 1
> NUMBER OF BOUNDARY CONDITIONS ..... : 2
> DESTINATION TIME ..... : 10950 DAYS

```

### COORDINAGE OF NODAL POINT

| Node | X-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 0.000        | 4.000        |
| 3    | 12.000       | 4.000        |
| 4    | 12.000       | 0.000        |

### Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 2      | 1         | 0              | NO       | NO       |
| 2    | 2      | 3      | 2         | 0              | YES      | NO       |
| 3    | 3      | 4      | 1         | 0              | NO       | NO       |

### PROPERTY OF MATERIALS

| SET# | MATERIALS | E          | A          | I          | G          | BETA       |
|------|-----------|------------|------------|------------|------------|------------|
| 1    | CONCRETE  | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 1.0000E+00 | 2.0000D+25 |
|      | STEEL     | 2.0000E+11 | 1.0000E+02 | 1.8000E-04 |            |            |
| 2    | CONCRETE  | 2.4911E+10 | 1.0000E+03 | 1.0000E-02 | 1.0000E+00 | 2.0000D+25 |
|      | STEEL     | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |            |            |

### Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | X-Displ. | Y-Displ. | Z-Rotation |
|----------|----------|----------|------------|
| 1        | R        | R        | U          |
| 4        | R        | R        | U          |

### CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 3          | 28          | 1 2 3              |

### UNIFORM LOAD

| STAGE# | MEMBER NO. | X-Uniform load | Y-Uniform load |
|--------|------------|----------------|----------------|
| 1      | 2          | 0.000E+00      | -5.000E+00     |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : EXAMPLE2                               ENGINEER : SIRIPHARPHUN
PROJECT : EXAMPLE2                             DATE : 08-31-1996   FILE : DATA\EXAMPLE4

```

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS
=> AT SEQUENCE 1 TO 1

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC)  | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|--------------|--------------|--------------|--------------|---------------|
| 1    | 1    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | -5.898060+00 | 9.072600-16   |
| 2    | 2    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | -5.898060+00 | -2.359220+01  |
| 2    | 2    | -5.898060+00 | 3.000000+01  | -2.359220+01 | 0.000000+00  | 0.000000+00  | 0.000000+00   |
| 3    | 3    | -5.898060+00 | -3.000000+01 | -2.359220+01 | 0.000000+00  | 0.000000+00  | 0.000000+00   |
| 3    | 3    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | 5.898060+00  | -2.359220+01  |
| 4    | 4    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | 5.898060+00  | -7.936360-16  |

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : AT TIME 28 TO 10950 DAYS

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC) | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|-------------|--------------|--------------|--------------|---------------|
| 1    | 1    | 0.000000+00  | 0.000000+00 | 0.000000+00  | 1.106870-16  | -4.954020+00 | -1.881310-15  |
| 2    | 2    | 0.000000+00  | 0.000000+00 | 0.000000+00  | 1.106870-16  | -4.954020+00 | -1.981610+01  |
| 2    | 2    | -4.954020+00 | 1.363930-16 | -1.981610+01 | 0.000000+00  | 0.000000+00  | 0.000000+00   |
| 3    | 3    | -4.954020+00 | 1.363930-16 | -1.981610+01 | 0.000000+00  | 0.000000+00  | 0.000000+00   |
| 3    | 3    | 0.000000+00  | 0.000000+00 | 0.000000+00  | 6.714870-16  | 4.954020+00  | -1.981610+01  |
| 4    | 4    | 0.000000+00  | 0.000000+00 | 0.000000+00  | 6.714870-16  | 4.954020+00  | -3.811190-15  |

```

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10950 DAYS

```

| MEM. | NODE | AXIAL(CONC)  | SHEAR(CONC)  | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |
|------|------|--------------|--------------|--------------|--------------|--------------|---------------|
| 1    | 1    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | -1.085210+01 | -9.740470-16  |
| 2    | 2    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | -1.085210+01 | -4.340830+01  |
| 2    | 2    | -1.085210+01 | 3.000000+01  | -4.340830+01 | 0.000000+00  | 0.000000+00  | 0.000000+00   |
| 3    | 3    | -1.085210+01 | -3.000000+01 | -4.340830+01 | 0.000000+00  | 0.000000+00  | 0.000000+00   |
| 3    | 3    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | 1.085210+01  | -4.340830+01  |
| 4    | 4    | 0.000000+00  | 0.000000+00  | 0.000000+00  | -3.000000+01 | 1.085210+01  | -4.604820-15  |

```

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : EXAMPLE2          ENGINEER : SIRIPHARPHUN
PROJECT : EXAMPLE2        DATE : 08-31-1996   FILE : DATA\EXAMPLE4
  
```

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS
=> AT SEQUENCE 1 TO 1
  
```

| MEMBER | NODE | AXIAL         | SHEAR         | MOMENT        |
|--------|------|---------------|---------------|---------------|
| 1      | 1    | -3.000000D+01 | -5.898058D+00 | 9.072804D-16  |
|        | 2    | -3.000000D+01 | -5.898058D+00 | -2.359223D+01 |
| 2      | 2    | -5.898058D+00 | 3.000000D+01  | -2.359223D+01 |
|        | 3    | -5.898058D+00 | -3.000000D+01 | -2.359223D+01 |
| 3      | 3    | -3.000000D+01 | 5.898058D+00  | -2.359223D+01 |
|        | 4    | -3.000000D+01 | 5.898058D+00  | -7.936360D-16 |

```

=> COMBINATION MEMBER FORCES : TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : AT TIME 28 TO 10950 DAYS
  
```

| MEMBER | NODE | AXIAL         | SHEAR         | MOMENT        |
|--------|------|---------------|---------------|---------------|
| 1      | 1    | 1.106870D-16  | -4.954016D+00 | -1.881308D-15 |
|        | 2    | 1.106870D-16  | -4.954016D+00 | -1.981607D+01 |
| 2      | 2    | -4.954016D+00 | 1.363926D-16  | -1.981607D+01 |
|        | 3    | -4.954016D+00 | 1.363926D-16  | -1.981607D+01 |
| 3      | 3    | 6.714870D-16  | 4.954016D+00  | -1.981607D+01 |
|        | 4    | 6.714870D-16  | 4.954016D+00  | -3.811187D-15 |

```

=> COMBINATION MEMBER FORCES : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10950 DAYS
  
```

| MEMBER | NODE | AXIAL         | SHEAR         | MOMENT        |
|--------|------|---------------|---------------|---------------|
| 1      | 1    | -3.000000D+01 | -1.085207D+01 | -9.740472D-16 |
|        | 2    | -3.000000D+01 | -1.085207D+01 | -4.340830D+01 |
| 2      | 2    | -1.085207D+01 | 3.000000D+01  | -4.340830D+01 |
|        | 3    | -1.085207D+01 | -3.000000D+01 | -4.340830D+01 |
| 3      | 3    | -3.000000D+01 | 1.085207D+01  | -4.340830D+01 |
|        | 4    | -3.000000D+01 | 1.085207D+01  | -4.604823D-15 |

```

=====
<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE-COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : EXAMPLE2                               ENGINEER : SIRIPHARPHUN
PROJECT : EXAMPLE2                             DATE : 08-31-1996   FILE : DATA\EXAMPLE4
=====

```

```

-----
=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS
=> AT SEQUENCE 1 TO 1

```

| NODE | X-MOVEMENT    | Y-MOVEMENT    | ROTATION      |
|------|---------------|---------------|---------------|
| 1    | 0.000000D+00  | 0.000000D+00  | 4.368928D-07  |
| 2    | 1.415534D-12  | -6.000000D-12 | -8.737867D-07 |
| 3    | -1.415534D-12 | -6.000000D-12 | 8.737867D-07  |
| 4    | 0.000000D+00  | 0.000000D+00  | -4.368928D-07 |

```

-----
=> COMBINATION JOINT DISPLACEMENT : TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : AT TIME 28 TO 10950 DAYS

```

| NODE | X-MOVEMENT    | Y-MOVEMENT   | ROTATION      |
|------|---------------|--------------|---------------|
| 1    | 0.000000D+00  | 0.000000D+00 | 3.669624D-07  |
| 2    | 7.165176D-12  | 2.213741D-29 | -7.339301D-07 |
| 3    | -7.165176D-12 | 1.342974D-28 | 7.339301D-07  |
| 4    | 0.000000D+00  | 0.000000D+00 | -3.669624D-07 |

```

-----
=> COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10950 DAYS

```

| NODE | X-MOVEMENT    | Y-MOVEMENT    | ROTATION      |
|------|---------------|---------------|---------------|
| 1    | 0.000000D+00  | 0.000000D+00  | 8.038552D-07  |
| 2    | 8.580710D-12  | -6.000000D-12 | -1.607717D-06 |
| 3    | -8.580710D-12 | -6.000000D-12 | 1.607717D-06  |
| 4    | 0.000000D+00  | 0.000000D+00  | -8.038552D-07 |

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=====
<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : EXAMPLE2                               ENGINEER : SIRIPHARPHUN
PROJECT : EXAMPLE2                             DATE : 08-31-1996   FILE : DATA\EXAMPLE4
=====

```

```

-----
=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS
=> AT SEQUENCE 1 TO 1

```

| NODE | AXIAL FORCE   | SHEAR FORCE   | BENDING MOMENT |
|------|---------------|---------------|----------------|
| 1    | -3.000000D+01 | -5.898058D+00 | 9.072604D-16   |
| 4    | -3.000000D+01 | -5.898058D+00 | -7.936360D-16  |

```

-----
=> COMBINATION REACTION OF SUPPORTS : TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : AT TIME 28 TO 10950 DAYS

```

| NODE | AXIAL FORCE  | SHEAR FORCE   | BENDING MOMENT |
|------|--------------|---------------|----------------|
| 1    | 1.106870D-16 | -4.954016D+00 | -1.881308D-15  |
| 4    | 6.714870D-16 | -4.954016D+00 | -3.811187D-15  |

```

-----
=> COMBINATION REACTION OF SUPPORTS : INSTANTANEOUS & TIME DEPENDENT
=> AT SEQUENCE 1 TO 1 : END OF TIME 10950 DAYS

```

| NODE | AXIAL FORCE   | SHEAR FORCE   | BENDING MOMENT |
|------|---------------|---------------|----------------|
| 1    | -3.000000D+01 | -1.085207D+01 | -9.740472D-16  |
| 4    | -3.000000D+01 | -1.085207D+01 | -4.604823D-15  |


  
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ภาคผนวก ข

รายละเอียดข้อมูลและผลการวิเคราะห์ตัวอย่างที่ 4  
อาคารโยทยก 2



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

\*\*\* DATA \*\*\*

> CODE REFERENCE ..... : ACI-209  
 > NUMBER OF TOTAL NODES ..... : 146  
 > NUMBER OF TOTAL MEMBERS ..... : 233  
 > NUMBER OF TOTAL MATERIALS ..... : 23  
 > NUMBER OF TOTAL CONSTRUCTIONAL STAGES .... : 69  
 > NUMBER OF BOUNDARY CONDITIONS ..... : 3  
 > DESTINATION TIME ..... : 3650 DAYS

COORDINAGE OF NODAL POINT

| Node | X-Coordinate | Y-Coordinate |
|------|--------------|--------------|
| 1    | 0.000        | 0.000        |
| 2    | 4.250        | 0.000        |
| 3    | 8.500        | 0.000        |
| 4    | 0.000        | 4.000        |
| 5    | 4.250        | 4.000        |
| 6    | 8.500        | 4.000        |
| 7    | 0.000        | 8.000        |
| 8    | 4.250        | 8.000        |
| 9    | 8.500        | 8.000        |
| 10   | 0.000        | 12.000       |
| 11   | 4.250        | 12.000       |
| 12   | 8.500        | 12.000       |
| 13   | 0.000        | 16.000       |
| 14   | 4.250        | 16.000       |
| 15   | 8.500        | 16.000       |
| 16   | 0.000        | 20.000       |
| 17   | 4.250        | 20.000       |
| 18   | 8.500        | 20.000       |
| 19   | 0.000        | 25.550       |
| 20   | 4.250        | 25.550       |
| 21   | 8.500        | 25.550       |
| 22   | 0.000        | 28.650       |
| 23   | 4.250        | 28.650       |
| 24   | 8.500        | 28.650       |
| 25   | 0.000        | 31.750       |
| 26   | 4.250        | 31.750       |
| 27   | 8.500        | 31.750       |
| 28   | 0.000        | 34.850       |
| 29   | 4.250        | 34.850       |
| 30   | 8.500        | 34.850       |
| 31   | 0.000        | 37.950       |
| 32   | 4.250        | 37.950       |
| 33   | 8.500        | 37.950       |
| 34   | 0.000        | 41.050       |
| 35   | 4.250        | 41.050       |
| 36   | 8.500        | 41.050       |
| 37   | 0.000        | 44.150       |
| 38   | 4.250        | 44.150       |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|    |       |         |
|----|-------|---------|
| 39 | 8.500 | 44.150  |
| 40 | 0.000 | 47.250  |
| 41 | 4.250 | 47.250  |
| 42 | 8.500 | 47.250  |
| 43 | 0.000 | 50.350  |
| 44 | 4.250 | 50.350  |
| 45 | 8.500 | 50.350  |
| 46 | 0.000 | 53.700  |
| 47 | 4.250 | 53.700  |
| 48 | 8.500 | 53.700  |
| 49 | 0.000 | 57.050  |
| 50 | 4.250 | 57.050  |
| 51 | 8.500 | 57.050  |
| 52 | 0.000 | 61.650  |
| 53 | 4.250 | 61.650  |
| 54 | 8.500 | 61.650  |
| 55 | 0.000 | 65.650  |
| 56 | 4.250 | 65.650  |
| 57 | 8.500 | 65.650  |
| 58 | 0.000 | 71.750  |
| 59 | 4.250 | 71.750  |
| 60 | 8.500 | 71.750  |
| 61 | 0.000 | 77.850  |
| 62 | 4.250 | 77.850  |
| 63 | 8.500 | 77.850  |
| 64 | 0.000 | 85.450  |
| 65 | 4.250 | 85.450  |
| 66 | 8.500 | 85.450  |
| 67 | 0.000 | 88.550  |
| 68 | 4.250 | 88.550  |
| 69 | 8.500 | 88.550  |
| 70 | 0.000 | 91.650  |
| 71 | 4.250 | 91.650  |
| 72 | 8.500 | 91.650  |
| 73 | 0.000 | 94.750  |
| 74 | 4.250 | 94.750  |
| 75 | 8.500 | 94.750  |
| 76 | 0.000 | 97.850  |
| 77 | 4.250 | 97.850  |
| 78 | 8.500 | 97.850  |
| 79 | 0.000 | 100.950 |
| 80 | 4.250 | 100.950 |
| 81 | 8.500 | 100.950 |
| 82 | 0.000 | 104.050 |
| 83 | 4.250 | 104.050 |
| 84 | 8.500 | 104.050 |
| 85 | 0.000 | 107.150 |
| 86 | 4.250 | 107.150 |
| 87 | 8.500 | 107.150 |
| 88 | 0.000 | 110.250 |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|     |       |         |
|-----|-------|---------|
| 89  | 4.250 | 110.250 |
| 90  | 8.500 | 110.250 |
| 91  | 0.000 | 113.350 |
| 92  | 4.250 | 113.350 |
| 93  | 8.500 | 113.350 |
| 94  | 0.000 | 116.450 |
| 95  | 4.250 | 116.450 |
| 96  | 8.500 | 116.450 |
| 97  | 0.000 | 119.550 |
| 98  | 4.250 | 119.550 |
| 99  | 8.500 | 119.550 |
| 100 | 0.000 | 122.650 |
| 101 | 4.250 | 122.650 |
| 102 | 8.500 | 122.650 |
| 103 | 0.000 | 125.750 |
| 104 | 4.250 | 125.750 |
| 105 | 8.500 | 125.750 |
| 106 | 0.000 | 128.850 |
| 107 | 4.250 | 128.850 |
| 108 | 8.500 | 128.850 |
| 109 | 0.000 | 131.950 |
| 110 | 4.250 | 131.950 |
| 111 | 8.500 | 131.950 |
| 112 | 0.000 | 135.050 |
| 113 | 4.250 | 135.050 |
| 114 | 8.500 | 135.050 |
| 115 | 4.250 | 138.150 |
| 116 | 8.500 | 138.150 |
| 117 | 4.250 | 141.250 |
| 118 | 8.500 | 141.250 |
| 119 | 4.250 | 144.350 |
| 120 | 8.500 | 144.350 |
| 121 | 4.250 | 147.450 |
| 122 | 8.500 | 147.450 |
| 123 | 4.250 | 150.550 |
| 124 | 8.500 | 150.550 |
| 125 | 4.250 | 153.650 |
| 126 | 8.500 | 153.650 |
| 127 | 4.250 | 156.750 |
| 128 | 8.500 | 156.750 |
| 129 | 4.250 | 159.850 |
| 130 | 8.500 | 159.850 |
| 131 | 4.250 | 162.950 |
| 132 | 8.500 | 162.950 |
| 133 | 4.250 | 166.050 |
| 134 | 8.500 | 166.050 |
| 135 | 4.250 | 169.150 |
| 136 | 8.500 | 169.150 |
| 137 | 4.250 | 172.250 |
| 138 | 8.500 | 172.250 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|     |       |         |
|-----|-------|---------|
| 139 | 4.250 | 175.350 |
| 140 | 8.500 | 175.350 |
| 141 | 4.250 | 178.450 |
| 142 | 8.500 | 178.450 |
| 143 | 4.250 | 181.550 |
| 144 | 8.500 | 181.550 |
| 145 | 4.250 | 184.650 |
| 146 | 8.500 | 184.650 |

### Node & Material of Element

| ELE. | NODE-I | NODE-J | MATERIAL# | CAST TIME(DAY) | CRP EFF. | SHK EFF. |
|------|--------|--------|-----------|----------------|----------|----------|
| 1    | 1      | 4      | 16        | 0              | YES      | NO       |
| 2    | 2      | 5      | 10        | 0              | YES      | NO       |
| 3    | 3      | 6      | 1         | 0              | YES      | NO       |
| 4    | 4      | 5      | 15        | 0              | NO       | NO       |
| 5    | 5      | 6      | 15        | 0              | NO       | NO       |
| 6    | 4      | 7      | 16        | 30             | YES      | NO       |
| 7    | 5      | 8      | 10        | 30             | YES      | NO       |
| 8    | 6      | 9      | 2         | 30             | YES      | NO       |
| 9    | 7      | 8      | 15        | 30             | NO       | NO       |
| 10   | 8      | 9      | 15        | 30             | NO       | NO       |
| 11   | 7      | 10     | 16        | 60             | YES      | NO       |
| 12   | 8      | 11     | 10        | 60             | YES      | NO       |
| 13   | 9      | 12     | 2         | 60             | YES      | NO       |
| 14   | 10     | 11     | 15        | 60             | NO       | NO       |
| 15   | 11     | 12     | 15        | 60             | NO       | NO       |
| 16   | 10     | 13     | 16        | 90             | YES      | NO       |
| 17   | 11     | 14     | 10        | 90             | YES      | NO       |
| 18   | 12     | 15     | 2         | 90             | YES      | NO       |
| 19   | 13     | 14     | 15        | 90             | NO       | NO       |
| 20   | 14     | 15     | 15        | 90             | NO       | NO       |
| 21   | 13     | 16     | 16        | 120            | YES      | NO       |
| 22   | 14     | 17     | 10        | 120            | YES      | NO       |
| 23   | 15     | 18     | 2         | 120            | YES      | NO       |
| 24   | 16     | 17     | 15        | 120            | NO       | NO       |
| 25   | 17     | 18     | 15        | 120            | NO       | NO       |
| 26   | 16     | 19     | 17        | 150            | YES      | NO       |
| 27   | 17     | 20     | 11        | 150            | YES      | NO       |
| 28   | 18     | 21     | 2         | 150            | YES      | NO       |
| 29   | 19     | 20     | 15        | 150            | NO       | NO       |
| 30   | 20     | 21     | 15        | 150            | NO       | NO       |
| 31   | 19     | 22     | 17        | 180            | YES      | NO       |
| 32   | 20     | 23     | 11        | 180            | YES      | NO       |
| 33   | 21     | 24     | 3         | 180            | YES      | NO       |
| 34   | 22     | 23     | 15        | 180            | NO       | NO       |
| 35   | 23     | 24     | 15        | 180            | NO       | NO       |
| 36   | 22     | 25     | 18        | 210            | YES      | NO       |
| 37   | 23     | 26     | 11        | 210            | YES      | NO       |
| 38   | 24     | 27     | 3         | 210            | YES      | NO       |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|    |    |    |    |     |     |    |
|----|----|----|----|-----|-----|----|
| 39 | 25 | 26 | 15 | 210 | NO  | NO |
| 40 | 26 | 27 | 15 | 210 | NO  | NO |
| 41 | 25 | 28 | 18 | 240 | YES | NO |
| 42 | 26 | 29 | 11 | 240 | YES | NO |
| 43 | 27 | 30 | 3  | 240 | YES | NO |
| 44 | 28 | 29 | 15 | 240 | NO  | NO |
| 45 | 29 | 30 | 15 | 240 | NO  | NO |
| 46 | 28 | 31 | 18 | 270 | YES | NO |
| 47 | 29 | 32 | 11 | 270 | YES | NO |
| 48 | 30 | 33 | 3  | 270 | YES | NO |
| 49 | 31 | 32 | 15 | 270 | NO  | NO |
| 50 | 32 | 33 | 15 | 270 | NO  | NO |
| 51 | 31 | 34 | 19 | 300 | YES | NO |
| 52 | 32 | 35 | 12 | 300 | YES | NO |
| 53 | 33 | 36 | 3  | 300 | YES | NO |
| 54 | 34 | 35 | 15 | 300 | NO  | NO |
| 55 | 35 | 36 | 15 | 300 | NO  | NO |
| 56 | 34 | 37 | 19 | 330 | YES | NO |
| 57 | 35 | 38 | 12 | 330 | YES | NO |
| 58 | 36 | 39 | 4  | 330 | YES | NO |
| 59 | 37 | 38 | 15 | 330 | NO  | NO |
| 60 | 38 | 39 | 15 | 330 | NO  | NO |
| 61 | 37 | 40 | 19 | 344 | YES | NO |
| 62 | 38 | 41 | 12 | 344 | YES | NO |
| 63 | 39 | 42 | 4  | 344 | YES | NO |
| 64 | 40 | 41 | 15 | 344 | NO  | NO |
| 65 | 41 | 42 | 15 | 344 | NO  | NO |
| 66 | 40 | 43 | 20 | 358 | YES | NO |
| 67 | 41 | 44 | 13 | 358 | YES | NO |
| 68 | 42 | 45 | 4  | 358 | YES | NO |
| 69 | 43 | 44 | 15 | 358 | NO  | NO |
| 70 | 44 | 45 | 15 | 358 | NO  | NO |
| 71 | 43 | 46 | 20 | 372 | YES | NO |
| 72 | 44 | 47 | 13 | 372 | YES | NO |
| 73 | 45 | 48 | 4  | 372 | YES | NO |
| 74 | 46 | 47 | 15 | 372 | NO  | NO |
| 75 | 47 | 48 | 15 | 372 | NO  | NO |
| 76 | 46 | 49 | 20 | 386 | YES | NO |
| 77 | 47 | 50 | 13 | 386 | YES | NO |
| 78 | 48 | 51 | 4  | 386 | YES | NO |
| 79 | 49 | 50 | 15 | 386 | NO  | NO |
| 80 | 50 | 51 | 15 | 386 | NO  | NO |
| 81 | 49 | 52 | 20 | 400 | YES | NO |
| 82 | 50 | 53 | 13 | 400 | YES | NO |
| 83 | 51 | 54 | 4  | 400 | YES | NO |
| 84 | 52 | 53 | 15 | 400 | NO  | NO |
| 85 | 53 | 54 | 15 | 400 | NO  | NO |
| 86 | 52 | 55 | 21 | 414 | YES | NO |
| 87 | 53 | 56 | 14 | 414 | YES | NO |
| 88 | 54 | 57 | 5  | 414 | YES | NO |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|     |    |    |    |     |     |    |
|-----|----|----|----|-----|-----|----|
| 89  | 55 | 56 | 15 | 414 | NO  | NO |
| 90  | 56 | 57 | 15 | 414 | NO  | NO |
| 91  | 55 | 58 | 21 | 428 | YES | NO |
| 92  | 56 | 59 | 14 | 428 | YES | NO |
| 93  | 57 | 60 | 5  | 428 | YES | NO |
| 94  | 58 | 59 | 15 | 428 | NO  | NO |
| 95  | 59 | 60 | 15 | 428 | NO  | NO |
| 96  | 58 | 61 | 21 | 442 | YES | NO |
| 97  | 59 | 62 | 14 | 442 | YES | NO |
| 98  | 60 | 63 | 5  | 442 | YES | NO |
| 99  | 61 | 62 | 15 | 442 | NO  | NO |
| 100 | 62 | 63 | 15 | 442 | NO  | NO |
| 101 | 61 | 64 | 22 | 463 | YES | NO |
| 102 | 62 | 65 | 14 | 463 | YES | NO |
| 103 | 63 | 66 | 5  | 463 | YES | NO |
| 104 | 64 | 65 | 15 | 463 | NO  | NO |
| 105 | 65 | 66 | 15 | 463 | NO  | NO |
| 106 | 64 | 67 | 22 | 473 | YES | NO |
| 107 | 65 | 68 | 23 | 473 | YES | NO |
| 108 | 66 | 69 | 6  | 473 | YES | NO |
| 109 | 67 | 68 | 15 | 473 | NO  | NO |
| 110 | 68 | 69 | 15 | 473 | NO  | NO |
| 111 | 67 | 70 | 22 | 483 | YES | NO |
| 112 | 68 | 71 | 23 | 483 | YES | NO |
| 113 | 69 | 72 | 6  | 483 | YES | NO |
| 114 | 70 | 71 | 15 | 483 | NO  | NO |
| 115 | 71 | 72 | 15 | 483 | NO  | NO |
| 116 | 70 | 73 | 22 | 493 | YES | NO |
| 117 | 71 | 74 | 23 | 493 | YES | NO |
| 118 | 72 | 75 | 6  | 493 | YES | NO |
| 119 | 73 | 74 | 15 | 493 | NO  | NO |
| 120 | 74 | 75 | 15 | 493 | NO  | NO |
| 121 | 73 | 76 | 22 | 503 | YES | NO |
| 122 | 74 | 77 | 23 | 503 | YES | NO |
| 123 | 75 | 78 | 6  | 503 | YES | NO |
| 124 | 76 | 77 | 15 | 503 | NO  | NO |
| 125 | 77 | 78 | 15 | 503 | NO  | NO |
| 126 | 76 | 79 | 22 | 513 | YES | NO |
| 127 | 77 | 80 | 23 | 513 | YES | NO |
| 128 | 78 | 81 | 6  | 513 | YES | NO |
| 129 | 79 | 80 | 15 | 513 | NO  | NO |
| 130 | 80 | 81 | 15 | 513 | NO  | NO |
| 131 | 79 | 82 | 22 | 523 | YES | NO |
| 132 | 80 | 83 | 23 | 523 | YES | NO |
| 133 | 81 | 84 | 6  | 523 | YES | NO |
| 134 | 82 | 83 | 15 | 523 | NO  | NO |
| 135 | 83 | 84 | 15 | 523 | NO  | NO |
| 136 | 82 | 85 | 22 | 533 | YES | NO |
| 137 | 83 | 86 | 23 | 533 | YES | NO |
| 138 | 84 | 87 | 7  | 533 | YES | NO |



<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN STRENGTHENING DATE : 04-27-1994 FILE : baiy3\_1

|     |     |     |    |     |     |    |
|-----|-----|-----|----|-----|-----|----|
| 139 | 85  | 86  | 15 | 533 | NO  | NO |
| 140 | 86  | 87  | 15 | 533 | NO  | NO |
| 141 | 85  | 88  | 22 | 543 | YES | NO |
| 142 | 86  | 89  | 23 | 543 | YES | NO |
| 143 | 87  | 90  | 7  | 543 | YES | NO |
| 144 | 88  | 89  | 15 | 543 | NO  | NO |
| 145 | 89  | 90  | 15 | 543 | NO  | NO |
| 146 | 88  | 91  | 22 | 553 | YES | NO |
| 147 | 89  | 92  | 23 | 553 | YES | NO |
| 148 | 90  | 93  | 7  | 553 | YES | NO |
| 149 | 91  | 92  | 15 | 553 | NO  | NO |
| 150 | 92  | 93  | 15 | 553 | NO  | NO |
| 151 | 91  | 94  | 22 | 563 | YES | NO |
| 152 | 92  | 95  | 23 | 563 | YES | NO |
| 153 | 93  | 96  | 7  | 563 | YES | NO |
| 154 | 94  | 95  | 15 | 563 | NO  | NO |
| 155 | 95  | 96  | 15 | 563 | NO  | NO |
| 156 | 94  | 97  | 22 | 573 | YES | NO |
| 157 | 95  | 98  | 23 | 573 | YES | NO |
| 158 | 96  | 99  | 7  | 573 | YES | NO |
| 159 | 97  | 98  | 15 | 573 | NO  | NO |
| 160 | 98  | 99  | 15 | 573 | NO  | NO |
| 161 | 97  | 100 | 22 | 583 | YES | NO |
| 162 | 98  | 101 | 23 | 583 | YES | NO |
| 163 | 99  | 102 | 8  | 583 | YES | NO |
| 164 | 100 | 101 | 15 | 583 | NO  | NO |
| 165 | 101 | 102 | 15 | 583 | NO  | NO |
| 166 | 100 | 103 | 22 | 593 | YES | NO |
| 167 | 101 | 104 | 23 | 593 | YES | NO |
| 168 | 102 | 105 | 8  | 593 | YES | NO |
| 169 | 103 | 104 | 15 | 593 | NO  | NO |
| 170 | 104 | 105 | 15 | 593 | NO  | NO |
| 171 | 103 | 106 | 22 | 603 | YES | NO |
| 172 | 104 | 107 | 23 | 603 | YES | NO |
| 173 | 105 | 108 | 8  | 603 | YES | NO |
| 174 | 106 | 107 | 15 | 603 | NO  | NO |
| 175 | 107 | 108 | 15 | 603 | NO  | NO |
| 176 | 106 | 109 | 22 | 613 | YES | NO |
| 177 | 107 | 110 | 23 | 613 | YES | NO |
| 178 | 108 | 111 | 8  | 613 | YES | NO |
| 179 | 109 | 110 | 15 | 613 | NO  | NO |
| 180 | 110 | 111 | 15 | 613 | NO  | NO |
| 181 | 109 | 112 | 22 | 623 | YES | NO |
| 182 | 110 | 113 | 23 | 623 | YES | NO |
| 183 | 111 | 114 | 8  | 623 | YES | NO |
| 184 | 112 | 113 | 15 | 623 | NO  | NO |
| 185 | 113 | 114 | 15 | 623 | NO  | NO |
| 186 | 113 | 115 | 23 | 633 | YES | NO |
| 187 | 114 | 116 | 8  | 633 | YES | NO |
| 188 | 115 | 116 | 15 | 633 | NO  | NO |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|     |     |     |    |     |     |    |
|-----|-----|-----|----|-----|-----|----|
| 189 | 115 | 117 | 23 | 643 | YES | NO |
| 190 | 116 | 118 | 8  | 643 | YES | NO |
| 191 | 117 | 118 | 15 | 643 | NO  | NO |
| 192 | 117 | 119 | 23 | 653 | YES | NO |
| 193 | 118 | 120 | 8  | 653 | YES | NO |
| 194 | 119 | 120 | 15 | 653 | NO  | NO |
| 195 | 119 | 121 | 23 | 663 | YES | NO |
| 196 | 120 | 122 | 8  | 663 | YES | NO |
| 197 | 121 | 122 | 15 | 663 | NO  | NO |
| 198 | 121 | 123 | 23 | 673 | YES | NO |
| 199 | 122 | 124 | 8  | 673 | YES | NO |
| 200 | 123 | 124 | 15 | 673 | NO  | NO |
| 201 | 123 | 125 | 23 | 683 | YES | NO |
| 202 | 124 | 126 | 8  | 683 | YES | NO |
| 203 | 125 | 126 | 15 | 683 | NO  | NO |
| 204 | 125 | 127 | 23 | 693 | YES | NO |
| 205 | 126 | 128 | 8  | 693 | YES | NO |
| 206 | 127 | 128 | 15 | 693 | NO  | NO |
| 207 | 127 | 129 | 23 | 703 | YES | NO |
| 208 | 128 | 130 | 9  | 703 | YES | NO |
| 209 | 129 | 130 | 15 | 703 | NO  | NO |
| 210 | 129 | 131 | 23 | 713 | YES | NO |
| 211 | 130 | 132 | 9  | 713 | YES | NO |
| 212 | 131 | 132 | 15 | 713 | NO  | NO |
| 213 | 131 | 133 | 23 | 723 | YES | NO |
| 214 | 132 | 134 | 9  | 723 | YES | NO |
| 215 | 133 | 134 | 15 | 723 | NO  | NO |
| 216 | 133 | 135 | 23 | 733 | YES | NO |
| 217 | 134 | 136 | 9  | 733 | YES | NO |
| 218 | 135 | 136 | 15 | 733 | NO  | NO |
| 219 | 135 | 137 | 23 | 743 | YES | NO |
| 220 | 136 | 138 | 9  | 743 | YES | NO |
| 221 | 137 | 138 | 15 | 743 | NO  | NO |
| 222 | 137 | 139 | 23 | 753 | YES | NO |
| 223 | 138 | 140 | 9  | 753 | YES | NO |
| 224 | 139 | 140 | 15 | 753 | NO  | NO |
| 225 | 139 | 141 | 23 | 763 | YES | NO |
| 226 | 140 | 142 | 9  | 763 | YES | NO |
| 227 | 141 | 142 | 15 | 763 | NO  | NO |
| 228 | 141 | 143 | 23 | 773 | YES | NO |
| 229 | 142 | 144 | 9  | 773 | YES | NO |
| 230 | 143 | 144 | 15 | 773 | NO  | NO |
| 231 | 143 | 145 | 23 | 783 | YES | NO |
| 232 | 144 | 146 | 9  | 783 | YES | NO |
| 233 | 145 | 146 | 15 | 783 | NO  | NO |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

### PROPERTY OF MATERIALS

| SET# | MATERIALS | E          | A          | I          | G          | BETA       |
|------|-----------|------------|------------|------------|------------|------------|
| 1    | CONCRETE  | 4.0242E+09 | 1.6700E+00 | 9.6000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 5.0935E-01 | 2.0000E-01 |            |            |
| 2    | CONCRETE  | 4.0242E+09 | 1.6600E+00 | 9.6000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 4.8970E-01 | 1.9000E-01 |            |            |
| 3    | CONCRETE  | 4.0242E+09 | 1.6700E+00 | 9.6000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 4.8263E-01 | 1.9000E-01 |            |            |
| 4    | CONCRETE  | 4.3020E+09 | 1.7000E+00 | 9.8000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 4.2670E-01 | 1.8500E-01 |            |            |
| 5    | CONCRETE  | 4.3020E+09 | 1.7000E+00 | 9.8000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 3.4340E-01 | 1.7960E-01 |            |            |
| 6    | CONCRETE  | 4.3020E+09 | 1.6900E+00 | 9.6000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 2.9406E-01 | 1.7000E-01 |            |            |
| 7    | CONCRETE  | 4.3020E+09 | 1.8700E+00 | 9.1000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 2.1879E-01 | 1.1568E-01 |            |            |
| 8    | CONCRETE  | 4.3020E+09 | 1.8700E+00 | 9.1000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 1.9448E-01 | 9.8500E-02 |            |            |
| 9    | CONCRETE  | 4.3020E+09 | 1.8700E+00 | 9.1000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 1.6830E-01 | 8.8500E-02 |            |            |
| 10   | CONCRETE  | 4.0242E+09 | 1.5200E+00 | 7.7440E-02 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 8.0560E-02 | 7.8900E-03 |            |            |
| 11   | CONCRETE  | 4.0242E+09 | 1.5400E+00 | 8.1280E-02 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 6.4680E-02 | 6.0500E-03 |            |            |
| 12   | CONCRETE  | 4.0242E+09 | 1.5600E+00 | 8.1492E-02 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 6.2400E-02 | 5.8380E-03 |            |            |
| 13   | CONCRETE  | 4.0242E+09 | 1.5700E+00 | 8.1900E-02 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 5.0240E-02 | 4.1270E-03 |            |            |
| 14   | CONCRETE  | 4.0242E+09 | 1.5700E+00 | 8.1900E-02 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 4.0820E-02 | 3.5550E-03 |            |            |
| 15   | CONCRETE  | 2.8455E+09 | 2.9410E-01 | 8.6600E-03 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 5.8820E-03 | 3.4000E-04 |            |            |
| 16   | CONCRETE  | 4.0242E+09 | 2.1700E+00 | 1.0519E+00 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 1.4760E-01 | 7.9780E-02 |            |            |
| 17   | CONCRETE  | 4.0242E+09 | 2.2000E+00 | 1.0800E+00 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 1.1660E-01 | 7.5000E-02 |            |            |
| 18   | CONCRETE  | 4.0242E+09 | 2.2400E+00 | 1.0907E+00 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 8.2880E-02 | 4.3050E-02 |            |            |
| 19   | CONCRETE  | 4.0242E+09 | 2.0000E+00 | 9.8300E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 6.2000E-02 | 4.0000E-02 |            |            |
| 20   | CONCRETE  | 4.0242E+09 | 2.0000E+00 | 9.8300E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 4.2000E-02 | 3.5300E-02 |            |            |
| 21   | CONCRETE  | 4.0242E+09 | 2.0000E+00 | 9.8300E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 3.6000E-02 | 3.0000E-02 |            |            |
| 22   | CONCRETE  | 4.0242E+09 | 2.0100E+00 | 9.9000E-01 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 3.0150E-02 | 2.5000E-02 |            |            |
| 23   | CONCRETE  | 4.0242E+09 | 1.5700E+00 | 8.1900E-02 | 1.0000E+09 | 2.0000D+21 |
|      | STEEL     | 2.0491E+10 | 2.5120E-02 | 3.2550E-03 |            |            |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : PROJECT#                               ENGINEER : CIVIL ENGINEER
PROJECT : COLUMN SHORTENING                     DATE : 04-27-1994      FILE : baiy3_1
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Boundary of Joint(R = RESTRAINT, U = UN-RESTRAINT)

| Node No. | X-Displ. | Y-Displ. | Z-Rotation |
|----------|----------|----------|------------|
| 1        | R        | R        | R          |
| 2        | R        | R        | R          |
| 3        | R        | R        | R          |

CONSTRUCTIONAL STAGES DATA

| STAGE# | TL.MEMBERS | CONST. TIME | ADDITIONAL MEMBERS |
|--------|------------|-------------|--------------------|
| 1      | 5          | 30          | 1 2 3 4 5          |
| 2      | 10         | 60          | 6 7 8 9 10         |
| 3      | 15         | 90          | 11 12 13 14 15     |
| 4      | 20         | 120         | 16 17 18 19 20     |
| 5      | 25         | 150         | 21 22 23 24 25     |
| 6      | 30         | 180         | 26 27 28 29 30     |
| 7      | 35         | 210         | 31 32 33 34 35     |
| 8      | 40         | 240         | 36 37 38 39 40     |
| 9      | 45         | 270         | 41 42 43 44 45     |
| 10     | 50         | 300         | 46 47 48 49 50     |
| 11     | 55         | 330         | 51 52 53 54 55     |
| 12     | 60         | 360         | 56 57 58 59 60     |

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|    |     |     |                     |
|----|-----|-----|---------------------|
| 13 | 65  | 374 | 61 62 63 64 65      |
| 14 | 70  | 388 | 66 67 68 69 70      |
| 15 | 75  | 402 | 71 72 73 74 75      |
| 16 | 80  | 416 | 76 77 78 79 80      |
| 17 | 85  | 430 | 81 82 83 84 85      |
| 18 | 90  | 444 | 86 87 88 89 90      |
| 19 | 95  | 458 | 91 92 93 94 95      |
| 20 | 100 | 472 | 96 97 98 99 100     |
| 21 | 105 | 493 | 101 102 103 104 105 |
| 22 | 110 | 503 | 106 107 108 109 110 |
| 23 | 115 | 513 | 111 112 113 114 115 |
| 24 | 120 | 523 | 116 117 118 119 120 |
| 25 | 125 | 533 | 121 122 123 124 125 |
| 26 | 130 | 543 | 126 127 128 129 130 |
| 27 | 135 | 553 | 131 132 133 134 135 |
| 28 | 140 | 563 | 136 137 138 139 140 |
| 29 | 145 | 573 | 141 142 143 144 145 |
| 30 | 150 | 583 | 146 147 148 149 150 |
| 31 | 155 | 593 | 151 152 153 154 155 |
| 32 | 160 | 603 | 156 157 158 159 160 |
| 33 | 165 | 613 | 161 162 163 164 165 |
| 34 | 170 | 623 | 166 167 168 169 170 |
| 35 | 175 | 633 | 171 172 173 174 175 |
| 36 | 180 | 643 | 176 177 178 179 180 |
| 37 | 185 | 653 | 181 182 183 184 185 |
| 38 | 188 | 663 | 186 187 188         |
| 39 | 191 | 673 | 189 190 191         |
| 40 | 194 | 683 | 192 193 194         |
| 41 | 197 | 693 | 195 196 197         |
| 42 | 200 | 703 | 198 199 200         |
| 43 | 203 | 713 | 201 202 203         |
| 44 | 206 | 723 | 204 205 206         |
| 45 | 209 | 733 | 207 208 209         |
| 46 | 212 | 743 | 210 211 212         |
| 47 | 215 | 753 | 213 214 215         |
| 48 | 218 | 763 | 216 217 218         |
| 49 | 221 | 773 | 219 220 221         |
| 50 | 224 | 783 | 222 223 224         |
| 51 | 227 | 793 | 225 226 227         |
| 52 | 230 | 803 | 228 229 230         |
| 53 | 233 | 813 | 231 232 233         |
| 54 | 233 | 833 |                     |
| 55 | 233 | 853 |                     |
| 56 | 233 | 873 |                     |
| 57 | 233 | 893 |                     |
| 58 | 233 | 913 |                     |
| 59 | 233 | 933 |                     |
| 60 | 233 | 953 |                     |
| 61 | 233 | 973 |                     |
| 62 | 233 | 993 |                     |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

|    |     |      |
|----|-----|------|
| 63 | 233 | 1013 |
| 64 | 233 | 1033 |
| 65 | 233 | 1053 |
| 66 | 233 | 1073 |
| 67 | 233 | 1093 |
| 68 | 233 | 1113 |
| 69 | 233 | 1133 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 1       | 4    | 0.000E+00 | -5.610E+04 | 0.000E+00 |
| 1       | 5    | 0.000E+00 | -3.130E+04 | 0.000E+00 |
| 1       | 6    | 0.000E+00 | -5.890E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 2       | 7    | 0.000E+00 | -3.960E+04 | 0.000E+00 |
| 2       | 8    | 0.000E+00 | -2.220E+04 | 0.000E+00 |
| 2       | 9    | 0.000E+00 | -4.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 3       | 10   | 0.000E+00 | -3.960E+04 | 0.000E+00 |
| 3       | 11   | 0.000E+00 | -2.220E+04 | 0.000E+00 |
| 3       | 12   | 0.000E+00 | -4.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 4       | 13   | 0.000E+00 | -3.960E+04 | 0.000E+00 |
| 4       | 14   | 0.000E+00 | -2.220E+04 | 0.000E+00 |
| 4       | 15   | 0.000E+00 | -4.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 5       | 16   | 0.000E+00 | -3.960E+04 | 0.000E+00 |
| 5       | 17   | 0.000E+00 | -2.220E+04 | 0.000E+00 |
| 5       | 18   | 0.000E+00 | -4.160E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 6       | 19   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 6       | 20   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 6       | 21   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 7       | 22   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 7       | 23   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 7       | 24   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 8       | 25   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 8       | 26   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 8       | 27   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 9       | 28   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 9       | 29   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 9       | 30   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 10      | 31   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 10      | 32   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 10      | 33   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 11      | 34   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 11      | 35   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 11      | 36   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 12      | 37   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 12      | 38   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 12      | 39   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 13      | 40   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 13      | 41   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 13      | 42   | 0.000E+00 | -3.760E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 14      | 43   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 14      | 44   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 14      | 45   | 0.000E+00 | -3.890E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 15      | 46   | 0.000E+00 | -3.580E+04 | 0.000E+00 |
| 15      | 47   | 0.000E+00 | -2.010E+04 | 0.000E+00 |
| 15      | 48   | 0.000E+00 | -3.890E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 16      | 49   | 0.000E+00 | -3.870E+04 | 0.000E+00 |
| 16      | 50   | 0.000E+00 | -2.490E+04 | 0.000E+00 |
| 16      | 51   | 0.000E+00 | -4.820E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 17      | 52   | 0.000E+00 | -3.680E+04 | 0.000E+00 |
| 17      | 53   | 0.000E+00 | -2.390E+04 | 0.000E+00 |
| 17      | 54   | 0.000E+00 | -4.620E+04 | 0.000E+00 |



<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 18      | 55   | 0.000E+00 | -3.680E+04 | 0.000E+00 |
| 18      | 56   | 0.000E+00 | -2.390E+04 | 0.000E+00 |
| 18      | 57   | 0.000E+00 | -4.620E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 19      | 58   | 0.000E+00 | -3.680E+04 | 0.000E+00 |
| 19      | 59   | 0.000E+00 | -2.390E+04 | 0.000E+00 |
| 19      | 60   | 0.000E+00 | -4.620E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 20      | 61   | 0.000E+00 | -3.680E+04 | 0.000E+00 |
| 20      | 62   | 0.000E+00 | -2.390E+04 | 0.000E+00 |
| 20      | 63   | 0.000E+00 | -4.620E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 21      | 64   | 0.000E+00 | -7.700E+04 | 0.000E+00 |
| 21      | 65   | 0.000E+00 | -4.640E+04 | 0.000E+00 |
| 21      | 66   | 0.000E+00 | -8.990E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 22      | 67   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 22      | 68   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 22      | 69   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 23      | 70   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 23      | 71   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 23      | 72   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 24      | 73   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 24      | 74   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 24      | 75   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 25      | 76   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 25      | 77   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 25      | 78   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 26      | 79   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 26      | 80   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 26      | 81   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 27      | 82   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 27      | 83   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 27      | 84   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 28      | 85   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 28      | 86   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 28      | 87   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 29      | 88   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 29      | 89   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 29      | 90   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 30      | 91   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 30      | 92   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 30      | 93   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 31      | 94   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 31      | 95   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 31      | 96   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 32      | 97   | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 32      | 98   | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 32      | 99   | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 33      | 100  | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 33      | 101  | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 33      | 102  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 34      | 103  | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 34      | 104  | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 34      | 105  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 35      | 106  | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 35      | 107  | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 35      | 108  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 36      | 109  | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 36      | 110  | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 36      | 111  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 37      | 112  | 0.000E+00 | -2.140E+04 | 0.000E+00 |
| 37      | 113  | 0.000E+00 | -2.440E+04 | 0.000E+00 |
| 37      | 114  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 38      | 115  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 38      | 116  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 39      | 117  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 39      | 118  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 40      | 119  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 40      | 120  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 41      | 121  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 41      | 122  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 42      | 123  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 42      | 124  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 43      | 125  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 43      | 126  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 44      | 127  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 44      | 128  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 45      | 129  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 45      | 130  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 46      | 131  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 46      | 132  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 47      | 133  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 47      | 134  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 48      | 135  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 48      | 136  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 49      | 137  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 49      | 138  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL STRENGTHENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 50      | 139  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 50      | 140  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 51      | 141  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 51      | 142  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 52      | 143  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 52      | 144  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 53      | 145  | 0.000E+00 | -1.580E+04 | 0.000E+00 |
| 53      | 146  | 0.000E+00 | -4.740E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 54      | 146  | 0.000E+00 | -1.001E+05 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 55      | 146  | 0.000E+00 | -7.470E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 56      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 57      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 58      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 59      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 60      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 61      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 62      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 63      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 64      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : baiy3\_1

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 65      | 146  | 0.000E+00 | -7.160E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 66      | 146  | 0.000E+00 | -6.000E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 67      | 146  | 0.000E+00 | -8.310E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 68      | 146  | 0.000E+00 | -5.360E+04 | 0.000E+00 |

JOINT LOAD

| STAGES# | Node | X-LOAD    | Y-LOAD     | Moment    |
|---------|------|-----------|------------|-----------|
| 69      | 146  | 0.000E+00 | -3.880E+04 | 0.000E+00 |

ศูนย์วิทยทรัพยากร  
 จุฬาลงกรณ์มหาวิทยาลัย



<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

=> COMBINATION MEMBER FORCES IN CONCRETE AND STEEL : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 69 : END OF TIME 3650 DAYS

| MEM. NODE | AXIAL(CONC) | SHEAR(CONC)  | MOMENT(CONC) | AXIAL(STEEL) | SHEAR(STEEL) | MOMENT(STEEL) |              |
|-----------|-------------|--------------|--------------|--------------|--------------|---------------|--------------|
| 1         | 1           | -6.38485D+05 | -1.44947D+02 | -2.92058D+04 | -5.79008D+05 | -1.65964D+02  | -1.94234D+04 |
|           | 4           | -6.38485D+05 | -1.44947D+02 | -2.97856D+04 | -5.79008D+05 | -1.65964D+02  | -2.00873D+04 |
| 2         | 2           | -6.65673D+05 | 2.00127D+01  | -2.15004D+03 | -4.16070D+05 | 4.84537D+01   | -2.01057D+03 |
|           | 5           | -6.65673D+05 | 2.00127D+01  | -2.06999D+03 | -4.16070D+05 | 4.84537D+01   | -1.81676D+03 |
| 3         | 3           | -6.38718D+05 | 5.64256D+01  | -2.48302D+04 | -2.94095D+06 | 1.86020D+02   | -4.95781D+04 |
|           | 6           | -6.38718D+05 | 5.64256D+01  | -2.46045D+04 | -2.94095D+06 | 1.86020D+02   | -4.88340D+04 |
| 4         | 4           | 3.22668D+01  | 1.62373D+02  | -3.39044D+02 | 4.43856D+00  | 4.25840D+01   | -8.88653D+01 |
|           | 5           | 3.22668D+01  | 1.62373D+02  | 3.51042D+02  | 4.43856D+00  | 4.25840D+01   | 9.21165D+01  |
| 5         | 5           | 4.96876D-01  | -3.41662D+02 | 7.21992D+02  | 1.44072D-01  | -9.12087D+01  | 1.92703D+02  |
|           | 6           | 4.96876D-01  | -3.41662D+02 | -7.30071D+02 | 1.44072D-01  | -9.12087D+01  | -1.94934D+02 |
| 6         | 4           | -6.08463D+05 | -1.52309D+02 | -2.95908D+04 | -5.52725D+05 | -1.95308D+02  | -1.98541D+04 |
|           | 7           | -6.08463D+05 | -1.52309D+02 | -3.02000D+04 | -5.52725D+05 | -1.95308D+02  | -2.06354D+04 |
| 7         | 5           | -6.46970D+05 | 3.07802D+01  | -2.21823D+03 | -4.04111D+05 | 7.37507D+01   | -2.14005D+03 |
|           | 8           | -6.46970D+05 | 3.07802D+01  | -2.09511D+03 | -4.04111D+05 | 7.37507D+01   | -1.84504D+03 |
| 8         | 6           | -6.46400D+05 | 5.12852D+01  | -2.55401D+04 | -2.87393D+06 | 1.91801D+02   | -4.88234D+04 |
|           | 9           | -6.46400D+05 | 5.12852D+01  | -2.53350D+04 | -2.87393D+06 | 1.91801D+02   | -4.80562D+04 |
| 9         | 7           | 2.35452D+01  | 3.31524D+02  | -6.99054D+02 | 3.28745D+00  | 8.72363D+01   | -1.83877D+02 |
|           | 8           | 2.35452D+01  | 3.31524D+02  | 7.09921D+02  | 3.28745D+00  | 8.72363D+01   | 1.86878D+02  |
| 10        | 8           | 3.77995D+01  | -4.91551D+02 | 1.03956D+03  | 5.27504D+00  | -1.31477D+02  | 2.78011D+02  |
|           | 9           | 3.77995D+01  | -4.91551D+02 | -1.04954D+03 | 5.27504D+00  | -1.31477D+02  | -2.80769D+02 |
| 11        | 7           | -5.86467D+05 | -1.51022D+02 | -2.98281D+04 | -5.34702D+05 | -2.23428D+02  | -2.01244D+04 |
|           | 10          | -5.86467D+05 | -1.51022D+02 | -3.04321D+04 | -5.34702D+05 | -2.23428D+02  | -2.10182D+04 |
| 12        | 8           | -6.33564D+05 | 2.56541D+01  | -2.21834D+03 | -3.96359D+05 | 6.26349D+01   | -2.14258D+03 |
|           | 11          | -6.33564D+05 | 2.56541D+01  | -2.11572D+03 | -3.96359D+05 | 6.26349D+01   | -1.89204D+03 |
| 13        | 9           | -6.36114D+05 | 4.37080D+01  | -2.54618D+04 | -2.84199D+06 | 2.42453D+02   | -4.92596D+04 |
|           | 12          | -6.36114D+05 | 4.37080D+01  | -2.52870D+04 | -2.84199D+06 | 2.42453D+02   | -4.82898D+04 |
| 14        | 10          | 4.79097D+01  | 5.10854D+02  | -1.08023D+03 | 6.42479D+00  | 1.34639D+02   | -2.84614D+02 |
|           | 11          | 4.79097D+01  | 5.10854D+02  | 1.09090D+03  | 6.42479D+00  | 1.34639D+02   | 2.87600D+02  |
| 15        | 11          | 9.68091D+01  | -6.13416D+02 | 1.29991D+03  | 1.31662D+01  | -1.64286D+02  | 3.48079D+02  |
|           | 12          | 9.68091D+01  | -6.13416D+02 | -1.30711D+03 | 1.31662D+01  | -1.64286D+02  | -3.50137D+02 |
| 16        | 10          | -5.64368D+05 | -1.66714D+02 | -2.98712D+04 | -5.16556D+05 | -2.62070D+02  | -2.02143D+04 |
|           | 13          | -5.64368D+05 | -1.66714D+02 | -3.05380D+04 | -5.16556D+05 | -2.62070D+02  | -2.12626D+04 |
| 17        | 11          | -6.20324D+05 | 5.56513D+00  | -2.18475D+03 | -3.88822D+05 | 2.70831D+01   | -2.09250D+03 |
|           | 14          | -6.20324D+05 | 5.56513D+00  | -2.16249D+03 | -3.88822D+05 | 2.70831D+01   | -1.98417D+03 |
| 18        | 12          | -6.25721D+05 | 5.52092D+01  | -2.54444D+04 | -2.81001D+06 | 3.40927D+02   | -4.97896D+04 |
|           | 15          | -6.25721D+05 | 5.52092D+01  | -2.52236D+04 | -2.81001D+06 | 3.40927D+02   | -4.84259D+04 |
| 19        | 13          | 2.12623D+01  | 7.08054D+02  | -1.50085D+03 | 2.72585D+00  | 1.86849D+02   | -3.95963D+02 |
|           | 14          | 2.12623D+01  | 7.08054D+02  | 1.50838D+03  | 2.72585D+00  | 1.86849D+02   | 3.98146D+02  |
| 20        | 14          | 7.12553D+01  | -7.05186D+02 | 1.49813D+03  | 9.78419D+00  | -1.88997D+02  | 4.01422D+02  |
|           | 15          | 7.12553D+01  | -7.05186D+02 | -1.49891D+03 | 9.78419D+00  | -1.88997D+02  | -4.01814D+02 |
| 21        | 13          | -5.42158D+05 | -1.75304D+02 | -2.97663D+04 | -4.98271D+05 | -2.77468D+02  | -2.01375D+04 |
|           | 16          | -5.42158D+05 | -1.75304D+02 | -3.04675D+04 | -4.98271D+05 | -2.77468D+02  | -2.12474D+04 |
| 22        | 14          | -6.07243D+05 | -6.48486D+00 | -2.13984D+03 | -3.81492D+05 | -1.79183D+01  | -1.99985D+03 |
|           | 17          | -6.07243D+05 | -6.48486D+00 | -2.16578D+03 | -3.81492D+05 | -1.79183D+01  | -2.07152D+03 |
| 23        | 15          | -6.15211D+05 | 5.93832D+01  | -2.54020D+04 | -2.77803D+06 | 4.17792D+02   | -5.01483D+04 |
|           | 18          | -6.15211D+05 | 5.93832D+01  | -2.51645D+04 | -2.77803D+06 | 4.17792D+02   | -4.84771D+04 |
| 24        | 16          | 2.41643D+00  | 9.32946D+02  | -1.98109D+03 | 2.29070D-01  | 2.46425D+02   | -5.27169D+02 |
|           | 17          | 2.41643D+00  | 9.32946D+02  | 1.98393D+03  | 2.29070D-01  | 2.46425D+02   | 5.24119D+02  |
| 25        | 17          | 9.87142D-02  | -7.65376D+02 | 1.62793D+03  | 4.21458D-01  | -2.05246D+02  | 4.36459D+02  |
|           | 18          | 9.87142D-02  | -7.65376D+02 | -1.62452D+03 | 4.21458D-01  | -2.05246D+02  | -4.35838D+02 |
| 26        | 16          | -5.87214D+05 | -1.72034D+02 | -3.04749D+04 | -4.12436D+05 | -2.83383D+02  | -1.87357D+04 |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>

OFFICE : PROJECT#

ENGINEER : CIVIL ENGINEER

PROJECT : COLUMN SHORTENING

DATE : 04-27-1994

FILE : DATA\baiy3\_1

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|      |    | 19           | -5.87214D+05 | -1.72034D+02 | -3.14297D+04 | -4.12436D+05   | -2.83383D+02 | -2.03084D+04 |
|------|----|--------------|--------------|--------------|--------------|----------------|--------------|--------------|
| 27   | 17 | -6.48631D+05 | -9.12862D+00 | -2.28524D+03 | -3.20054D+05 | -1.31493D+01   | -1.50840D+03 |              |
|      | 20 | -6.48631D+05 | -9.12862D+00 | -2.33591D+03 | -3.20054D+05 | -1.31493D+01   | -1.58137D+03 |              |
| 28   | 18 | -6.04598D+05 | 4.04537D+01  | -2.53528D+04 | -2.74607D+06 | 4.37242D+02    | -5.03495D+04 |              |
|      | 21 | -6.04598D+05 | 4.04537D+01  | -2.51283D+04 | -2.74607D+06 | 4.37242D+02    | -4.79228D+04 |              |
| 29   | 19 | -7.09955D+00 | 1.29904D+03  | -2.75536D+03 | -2.08129D-01 | 3.43132D+02    | -7.27655D+02 |              |
|      | 20 | -7.09955D+00 | 1.29904D+03  | -2.76556D+03 | -2.08129D-01 | 3.43132D+02    | 7.30656D+02  |              |
| NODE |    | AXIAL FORCE  |              | SHEAR FORCE  |              | BENDING MOMENT |              |              |
| 30   | 20 | 1.57127D+02  | -1.16825D+03 | 2.48282D+03  | 2.14023D+01  | -3.12019D+02   | 6.62976D+02  |              |
|      | 21 | 1.57127D+02  | -1.16825D+03 | -2.48225D+03 | 2.14023D+01  | -3.12019D+02   | -6.63104D+02 |              |
| 31   | 19 | -5.64141D+05 | -1.16519D+02 | -2.99150D+04 | -3.98066D+05 | -3.31591D+02   | -1.83401D+04 |              |
|      | 22 | -5.64141D+05 | -1.16519D+02 | -3.02763D+04 | -3.98066D+05 | -3.31591D+02   | -1.93680D+04 |              |
| 32   | 20 | -6.36499D+05 | -1.04898D+02 | -2.15752D+03 | -3.15209D+05 | -1.03218D+02   | -1.40933D+03 |              |
|      | 23 | -6.36499D+05 | -1.04898D+02 | -2.48270D+03 | -3.15209D+05 | -1.03218D+02   | -1.72931D+03 |              |
| 33   | 21 | -6.05955D+05 | 2.63932D+01  | -2.54709D+04 | -2.70563D+06 | 6.29832D+02    | -5.07255D+04 |              |
|      | 24 | -6.05955D+05 | 2.63932D+01  | -2.53891D+04 | -2.70563D+06 | 6.29832D+02    | -4.87731D+04 |              |
| 34   | 22 | 1.89477D+02  | 1.54193D+03  | -3.28534D+03 | 2.51372D+01  | 4.07391D+02    | -8.67879D+02 |              |
|      | 23 | 1.89477D+02  | 1.54193D+03  | 3.26784D+03  | 2.51372D+01  | 4.07391D+02    | 8.63534D+02  |              |
| 35   | 23 | 1.74906D+02  | -1.31374D+03 | 2.79547D+03  | 2.37857D+01  | -3.50582D+02   | 7.45901D+02  |              |
|      | 24 | 1.74906D+02  | -1.31374D+03 | -2.78794D+03 | 2.37857D+01  | -3.50582D+02   | -7.44074D+02 |              |
| 36   | 22 | -6.24001D+05 | -3.33807D+02 | -3.38873D+04 | -3.00457D+05 | -3.28918D+02   | -1.16038D+04 |              |
|      | 25 | -6.24001D+05 | -3.33807D+02 | -3.49221D+04 | -3.00457D+05 | -3.28918D+02   | -1.26234D+04 |              |
| 37   | 23 | -6.24582D+05 | -9.63469D+01 | -2.19832D+03 | -3.10639D+05 | -9.58455D+01   | -1.42367D+03 |              |
|      | 26 | -6.24582D+05 | -9.63469D+01 | -2.49700D+03 | -3.10639D+05 | -9.58455D+01   | -1.72080D+03 |              |
| 38   | 24 | -5.95206D+05 | 4.40824D+01  | -2.57853D+04 | -2.67711D+06 | 8.10834D+02    | -5.19089D+04 |              |
|      | 27 | -5.95206D+05 | 4.40824D+01  | -2.56486D+04 | -2.67711D+06 | 8.10834D+02    | -4.93953D+04 |              |
| 39   | 25 | 3.36648D+02  | 1.56599D+03  | -3.32067D+03 | 4.45442D+01  | 4.13907D+02    | -8.77588D+02 |              |
|      | 26 | 3.36648D+02  | 1.56599D+03  | 3.33481D+03  | 4.45442D+01  | 4.13907D+02    | 8.81518D+02  |              |
| 40   | 26 | 1.99314D+02  | -1.45516D+03 | 3.09369D+03  | 2.66749D+01  | -3.87973D+02   | 8.24742D+02  |              |
|      | 27 | 1.99314D+02  | -1.45516D+03 | -3.09074D+03 | 2.66749D+01  | -3.87973D+02   | -8.24144D+02 |              |
| 41   | 25 | -5.97410D+05 | -5.73940D+02 | -3.23927D+04 | -2.89268D+05 | -4.69976D+02   | -1.09546D+04 |              |
|      | 28 | -5.97410D+05 | -5.73940D+02 | -3.41719D+04 | -2.89268D+05 | -4.69976D+02   | -1.24115D+04 |              |
| 42   | 26 | -6.12688D+05 | -2.34886D+01 | -2.33636D+03 | -3.06256D+05 | -1.35010D+01   | -1.58354D+03 |              |
|      | 29 | -6.12688D+05 | -2.34886D+01 | -2.40918D+03 | -3.06256D+05 | -1.35010D+01   | -1.62540D+03 |              |
| 43   | 27 | -5.84101D+05 | 8.67612D+01  | -2.61058D+04 | -2.64878D+06 | 9.94145D+02    | -5.28530D+04 |              |
|      | 30 | -5.84101D+05 | 8.67612D+01  | -2.58368D+04 | -2.64878D+06 | 9.94145D+02    | -4.97712D+04 |              |
| 44   | 28 | 2.37725D+01  | 1.63872D+03  | -3.47398D+03 | 2.85467D+00  | 4.33328D+02    | -9.18537D+02 |              |
|      | 29 | 2.37725D+01  | 1.63872D+03  | 3.49057D+03  | 2.85467D+00  | 4.33328D+02    | 9.23108D+02  |              |
| 45   | 29 | 3.93523D+01  | -1.60124D+03 | 3.40369D+03  | 5.41638D+00  | -4.26622D+02   | 9.06755D+02  |              |
|      | 30 | 3.93523D+01  | -1.60124D+03 | -3.40159D+03 | 5.41638D+00  | -4.26622D+02   | -9.06389D+02 |              |
| 46   | 28 | -5.70589D+05 | -5.80030D+02 | -3.15270D+04 | -2.78217D+05 | -4.90513D+02   | -1.06639D+04 |              |
|      | 31 | -5.70589D+05 | -5.80030D+02 | -3.33251D+04 | -2.78217D+05 | -4.90513D+02   | -1.21845D+04 |              |
| 47   | 29 | -6.00809D+05 | -3.49653D+01 | -2.33454D+03 | -3.02136D+05 | -2.01658D+01   | -1.59680D+03 |              |
|      | 32 | -6.00809D+05 | -3.49653D+01 | -2.44294D+03 | -3.02136D+05 | -2.01658D+01   | -1.65932D+03 |              |
| 48   | 30 | -5.72521D+05 | 8.32140D+01  | -2.63623D+04 | -2.62073D+06 | 1.04246D+03    | -5.35537D+04 |              |
|      | 33 | -5.72521D+05 | 8.32140D+01  | -2.61043D+04 | -2.62073D+06 | 1.04246D+03    | -5.03221D+04 |              |
| 49   | 31 | 6.32425D+01  | 1.75838D+03  | -3.73646D+03 | 8.05971D+00  | 4.65294D+02    | -9.88612D+02 |              |
|      | 32 | 6.32425D+01  | 1.75838D+03  | 3.73664D+03  | 8.05971D+00  | 4.65294D+02    | 9.88886D+02  |              |
| 50   | 32 | -8.99419D+01 | -1.75221D+03 | 3.72474D+03  | -1.20233D+01 | -4.66652D+02   | 9.91899D+02  |              |
|      | 33 | -8.99419D+01 | -1.75221D+03 | -3.72214D+03 | -1.20233D+01 | -4.66652D+02   | -9.91372D+02 |              |
| 51   | 31 | -5.76083D+05 | -6.12637D+02 | -3.02521D+04 | -2.34699D+05 | -5.29208D+02   | -1.05323D+04 |              |
|      | 34 | -5.76083D+05 | -6.12637D+02 | -3.21513D+04 | -2.34699D+05 | -5.29208D+02   | -1.21729D+04 |              |
| 52   | 32 | -5.98949D+05 | 4.41654D+01  | -2.45221D+03 | -2.88337D+05 | 7.39709D+01    | -1.64116D+03 |              |
|      | 35 | -5.98949D+05 | 4.41654D+01  | -2.31529D+03 | -2.88337D+05 | 7.39709D+01    | -1.41185D+03 |              |
| 53   | 33 | -5.60254D+05 | 6.26492D+01  | -2.67072D+04 | -2.59318D+06 | 9.61060D+02    | -5.44327D+04 |              |
|      | 36 | -5.60254D+05 | 6.26492D+01  | -2.65130D+04 | -2.59318D+06 | 9.61060D+02    | -5.14534D+04 |              |
| 54   | 34 | 1.30348D+02  | 1.56711D+03  | -3.31369D+03 | 1.68030D+01  | 4.14965D+02    | -8.77360D+02 |              |

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 << THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1  
 =====

| NODE  | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|-------|--------------|--------------|----------------|
| 35    | 1.30348D+02  | 1.56711D+03  | 3.34651D+03    |
| 55 35 | -4.66192D+01 | -1.90320D+03 | 4.03395D+03    |
| 36    | -4.66192D+01 | -1.90320D+03 | -4.05467D+03   |
| 56 34 | -5.47122D+05 | -7.19987D+02 | -2.96932D+04   |
| 37    | -5.47122D+05 | -7.19987D+02 | -3.19251D+04   |
| 57 35 | -5.86402D+05 | 1.39628D+02  | -2.68390D+03   |
| 38    | -5.86402D+05 | 1.39628D+02  | -2.25105D+03   |
| 58 36 | -6.65318D+05 | 9.82650D+01  | -2.93648D+04   |
| 39    | -6.65318D+05 | 9.82650D+01  | -2.90602D+04   |
| 59 37 | 1.64754D+01  | 1.41761D+03  | -2.99935D+03   |
| 38    | 1.64754D+01  | 1.41761D+03  | 3.02547D+03    |
| 60 38 | -6.54818D+01 | -1.82654D+03 | 3.87427D+03    |
| 39    | -6.54818D+01 | -1.82654D+03 | -3.88851D+03   |
| 61 37 | -5.20186D+05 | -7.50735D+02 | -2.96995D+04   |
| 40    | -5.20186D+05 | -7.50735D+02 | -3.20268D+04   |
| 62 38 | -5.75276D+05 | 1.86935D+02  | -2.71865D+03   |
| 41    | -5.75276D+05 | 1.86935D+02  | -2.13915D+03   |
| 63 39 | -6.55443D+05 | 1.05788D+02  | -2.98241D+04   |
| 42    | -6.55443D+05 | 1.05788D+02  | -2.94962D+04   |
| 64 40 | 9.56322D+00  | 1.34112D+03  | -2.83322D+03   |
| 41    | 9.56322D+00  | 1.34112D+03  | 2.86653D+03    |
| 65 41 | -5.98161D+01 | -1.78415D+03 | 3.77689D+03    |
| 42    | -5.98161D+01 | -1.78415D+03 | -3.80574D+03   |
| 66 40 | -5.47453D+05 | -8.14032D+02 | -3.08839D+04   |
| 43    | -5.47453D+05 | -8.14032D+02 | -3.34074D+04   |
| 67 41 | -6.05453D+05 | 2.71210D+02  | -3.02687D+03   |
| 44    | -6.05453D+05 | 2.71210D+02  | -2.18612D+03   |
| 68 42 | -6.45502D+05 | 1.10041D+02  | -3.02415D+04   |
| 45    | -6.45502D+05 | 1.10041D+02  | -2.99004D+04   |
| 69 43 | 2.96690D+01  | 1.26359D+03  | -2.66515D+03   |
| 44    | 2.96690D+01  | 1.26359D+03  | 2.70513D+03    |
| 70 44 | -2.62701D+01 | -1.91666D+03 | 4.05748D+03    |
| 45    | -2.62701D+01 | -1.91666D+03 | -4.08833D+03   |
| 71 43 | -5.17857D+05 | -8.40428D+02 | -3.13127D+04   |
| 46    | -5.17857D+05 | -8.40428D+02 | -3.41281D+04   |
| 72 44 | -5.93519D+05 | 2.99265D+02  | -3.11637D+03   |
| 47    | -5.93519D+05 | 2.99265D+02  | -2.11383D+03   |
| 73 45 | -6.35238D+05 | 1.21443D+02  | -3.07127D+04   |
| 48    | -6.35238D+05 | 1.21443D+02  | -3.03059D+04   |
| 74 46 | 2.37746D+01  | 1.23342D+03  | -2.59340D+03   |
| 47    | 2.37746D+01  | 1.23342D+03  | 2.64864D+03    |
| 75 47 | -1.20305D+02 | -2.09133D+03 | 4.42238D+03    |
| 48    | -1.20305D+02 | -2.09133D+03 | -4.46577D+03   |
| 76 46 | -4.88285D+05 | -8.60029D+02 | -3.20871D+04   |
| 49    | -4.88285D+05 | -8.60029D+02 | -3.49682D+04   |
| 77 47 | -5.81677D+05 | 3.86781D+02  | -3.33261D+03   |
| 50    | -5.81677D+05 | 3.86781D+02  | -2.03689D+03   |
| 78 48 | -6.24821D+05 | 1.00669D+02  | -3.12052D+04   |
| 51    | -6.24821D+05 | 1.00669D+02  | -3.08679D+04   |
| 79 49 | -1.97802D+02 | 1.24196D+03  | -2.60461D+03   |
| 50    | -1.97802D+02 | 1.24196D+03  | 2.67370D+03    |
| 80 50 | -1.42187D+02 | -2.30153D+03 | 4.86271D+03    |
| 51    | -1.42187D+02 | -2.30153D+03 | -4.91879D+03   |
| 81 49 | -4.56464D+05 | -7.19959D+02 | -3.29165D+04   |
| 52    | -4.56464D+05 | -7.19959D+02 | -3.62283D+04   |
| 82 50 | -5.66702D+05 | 3.55867D+02  | -3.54248D+03   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

| NODE   | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|--------|--------------|--------------|----------------|
| 83 53  | -5.66702D+05 | 3.55867D+02  | -1.90548D+03   |
| 83 51  | -6.12773D+05 | 6.92135D+01  | -3.18697D+04   |
| 83 54  | -6.12773D+05 | 6.92135D+01  | -3.15513D+04   |
| 84 52  | 6.48504D+01  | 1.22286D+03  | -2.54185D+03   |
| 84 53  | 6.48504D+01  | 1.22286D+03  | 2.65531D+03    |
| 85 53  | -1.48105D+02 | -2.61358D+03 | 5.50282D+03    |
| 85 54  | -1.48105D+02 | -2.61358D+03 | -5.60489D+03   |
| 86 52  | -4.40414D+05 | -8.14802D+02 | -3.56144D+04   |
| 86 55  | -4.40414D+05 | -8.14802D+02 | -3.88736D+04   |
| 87 53  | -5.84532D+05 | 5.22501D+02  | -4.08767D+03   |
| 87 56  | -5.84532D+05 | 5.22501D+02  | -1.99767D+03   |
| 88 54  | -7.30346D+05 | 3.63514D+01  | -3.34008D+04   |
| 88 57  | -7.30346D+05 | 3.63514D+01  | -3.32554D+04   |
| 89 55  | -3.54628D+02 | 1.24095D+03  | -2.58601D+03   |
| 89 56  | -3.54628D+02 | 1.24095D+03  | 2.68805D+03    |
| 90 56  | 7.04724D+01  | -2.44618D+03 | 5.15676D+03    |
| 90 57  | 7.04724D+01  | -2.44618D+03 | -5.23952D+03   |
| 91 55  | -4.09128D+05 | -5.43165D+02 | -3.67064D+04   |
| 91 58  | -4.09128D+05 | -5.43165D+02 | -4.00197D+04   |
| 92 56  | -5.69591D+05 | 2.38932D+02  | -3.82288D+03   |
| 92 59  | -5.69591D+05 | 2.38932D+02  | -2.36540D+03   |
| 93 57  | -7.16225D+05 | 5.58365D+01  | -3.43257D+04   |
| 93 60  | -7.16225D+05 | 5.58365D+01  | -3.39851D+04   |
| 94 58  | -1.23147D+02 | 1.29356D+03  | -2.68899D+03   |
| 94 59  | -1.23147D+02 | 1.29356D+03  | 2.80863D+03    |
| 95 59  | -1.16976D+02 | -2.33147D+03 | 4.90543D+03    |
| 95 60  | -1.16976D+02 | -2.33147D+03 | -5.00332D+03   |
| 96 58  | -3.77814D+05 | -4.43744D+02 | -3.77769D+04   |
| 96 61  | -3.77814D+05 | -4.43744D+02 | -4.04837D+04   |
| 97 59  | -5.54573D+05 | 2.30156D+02  | -3.90032D+03   |
| 97 62  | -5.54573D+05 | 2.30156D+02  | -2.49636D+03   |
| 98 60  | -7.02082D+05 | 2.65494D+01  | -3.49271D+04   |
| 98 63  | -7.02082D+05 | 2.65494D+01  | -3.47652D+04   |
| 99 61  | 6.17064D+01  | 1.37440D+03  | -2.86839D+03   |
| 99 62  | 6.17064D+01  | 1.37440D+03  | 2.97282D+03    |
| 100 62 | 1.67211D+02  | -2.32292D+03 | 4.88576D+03    |
| 100 63 | 1.67211D+02  | -2.32292D+03 | -4.98664D+03   |
| 101 61 | -3.57750D+05 | -5.30266D+02 | -3.97305D+04   |
| 101 64 | -3.57750D+05 | -5.30266D+02 | -4.37605D+04   |
| 102 62 | -5.38673D+05 | 1.61098D+02  | -3.87630D+03   |
| 102 65 | -5.38673D+05 | 1.61098D+02  | -2.65196D+03   |
| 103 63 | -6.83644D+05 | 7.06396D+01  | -3.55702D+04   |
| 103 66 | -6.83644D+05 | 7.06396D+01  | -3.50333D+04   |
| 104 64 | 1.02829D+03  | 1.38532D+03  | -2.86937D+03   |
| 104 65 | 1.02829D+03  | 1.38532D+03  | 3.01823D+03    |
| 105 65 | 6.49948D+02  | -2.43288D+03 | 5.11410D+03    |
| 105 66 | 6.49948D+02  | -2.43288D+03 | -5.22563D+03   |
| 106 64 | -2.92002D+05 | -1.34365D+03 | -4.12385D+04   |
| 106 67 | -2.92002D+05 | -1.34365D+03 | -4.54038D+04   |
| 107 65 | -5.60721D+05 | 4.07936D+02  | -4.27770D+03   |
| 107 68 | -5.60721D+05 | 4.07936D+02  | -3.01310D+03   |
| 108 66 | -7.51032D+05 | 1.94056D+02  | -3.68293D+04   |
| 108 69 | -7.51032D+05 | 1.94056D+02  | -3.62278D+04   |
| 109 67 | -6.36874D+01 | 1.77326D+03  | -3.74429D+03   |
| 109 68 | -6.36874D+01 | 1.77326D+03  | 3.79206D+03    |
| 110 68 | 2.26970D+02  | -2.37297D+03 | 5.03728D+03    |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

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| NODE   | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|--------|--------------|--------------|----------------|
| 69     | 2.26970D+02  | -2.37297D+03 | -5.04784D+03   |
| 111 67 | -2.72195D+05 | -1.27763D+03 | -4.20846D+04   |
| 70     | -2.72195D+05 | -1.27763D+03 | -4.60453D+04   |
| 112 68 | -5.44509D+05 | 2.13908D+02  | -3.90508D+03   |
| 71     | -5.44509D+05 | 2.13908D+02  | -3.24197D+03   |
| 113 69 | -7.36312D+05 | 2.04425D+02  | -3.70523D+04   |
| 72     | -7.36312D+05 | 2.04425D+02  | -3.64186D+04   |
| 69     | 2.26970D+02  | -2.37297D+03 | -5.04784D+03   |
| 111 67 | -2.72195D+05 | -1.27763D+03 | -4.20846D+04   |
| 70     | -2.72195D+05 | -1.27763D+03 | -4.60453D+04   |
| 112 68 | -5.44509D+05 | 2.13908D+02  | -3.90508D+03   |
| 71     | -5.44509D+05 | 2.13908D+02  | -3.24197D+03   |
| 113 69 | -7.36312D+05 | 2.04425D+02  | -3.70523D+04   |
| 72     | -7.36312D+05 | 2.04425D+02  | -3.64186D+04   |
| 114 70 | -1.48591D+02 | 1.77415D+03  | -3.75145D+03   |
| 71     | -1.48591D+02 | 1.77415D+03  | 3.78868D+03    |
| 115 71 | -5.21778D+01 | -2.18714D+03 | 4.64156D+03    |
| 72     | -5.21778D+01 | -2.18714D+03 | -4.65378D+03   |
| 116 70 | -2.52399D+05 | -1.14634D+03 | -4.27427D+04   |
| 73     | -2.52399D+05 | -1.14634D+03 | -4.62963D+04   |
| 117 71 | -5.28098D+05 | 1.46197D+02  | -3.83351D+03   |
| 74     | -5.28098D+05 | 1.46197D+02  | -3.38030D+03   |
| 118 72 | -7.21682D+05 | 1.73367D+02  | -3.70911D+04   |
| 75     | -7.21682D+05 | 1.73367D+02  | -3.65537D+04   |
| 119 73 | -2.99361D+01 | 1.74649D+03  | -3.69802D+03   |
| 74     | -2.99361D+01 | 1.74649D+03  | 3.72458D+03    |
| 120 74 | 4.78571D+01  | -2.03045D+03 | 4.30945D+03    |
| 75     | 4.78571D+01  | -2.03045D+03 | -4.31996D+03   |
| 121 73 | -2.32642D+05 | -1.11882D+03 | -4.30641D+04   |
| 76     | -2.32642D+05 | -1.11882D+03 | -4.65325D+04   |
| 122 74 | -5.11487D+05 | 9.14904D+01  | -3.76262D+03   |
| 77     | -5.11487D+05 | 9.14904D+01  | -3.47900D+03   |
| 123 75 | -7.07136D+05 | 1.81196D+02  | -3.70863D+04   |
| 78     | -7.07136D+05 | 1.81196D+02  | -3.65246D+04   |
| 124 76 | 2.95712D+02  | 1.70555D+03  | -3.61517D+03   |
| 77     | 2.95712D+02  | 1.70555D+03  | 3.63341D+03    |
| 125 77 | 3.50337D+02  | -1.89468D+03 | 4.02146D+03    |
| 78     | 3.50337D+02  | -1.89468D+03 | -4.03091D+03   |
| 126 76 | -2.12939D+05 | -1.36398D+03 | -4.33976D+04   |
| 79     | -2.12939D+05 | -1.36398D+03 | -4.76260D+04   |
| 127 77 | -4.94683D+05 | 5.20315D+01  | -3.70488D+03   |
| 80     | -4.94683D+05 | 5.20315D+01  | -3.54359D+03   |
| 128 78 | -6.92670D+05 | 2.76728D+02  | -3.69252D+04   |
| 81     | -6.92670D+05 | 2.76728D+02  | -3.60673D+04   |
| 129 79 | 5.52870D+02  | 1.64844D+03  | -3.49030D+03   |
| 80     | 5.52870D+02  | 1.64844D+03  | 3.51558D+03    |
| 130 80 | 7.00697D+02  | -1.77045D+03 | 3.76024D+03    |
| 81     | 7.00697D+02  | -1.77045D+03 | -3.76417D+03   |
| 131 79 | -1.93307D+05 | -1.81769D+03 | -4.46277D+04   |
| 82     | -1.93307D+05 | -1.81769D+03 | -5.02625D+04   |
| 132 80 | -4.77682D+05 | -5.87509D+01 | -3.65291D+03   |
| 83     | -4.77682D+05 | -5.87509D+01 | -3.83504D+03   |
| 133 81 | -6.78285D+05 | 4.64060D+02  | -3.63375D+04   |
| 84     | -6.78285D+05 | 4.64060D+02  | -3.48989D+04   |
| 134 82 | -1.98586D+02 | 1.52911D+03  | -3.22639D+03   |
| 83     | -1.98586D+02 | 1.52911D+03  | 3.27231D+03    |
| 135 83 | -1.68728D+02 | -1.66761D+03 | 3.57234D+03    |
| 84     | -1.68728D+02 | -1.66761D+03 | -3.51502D+03   |
| 136 82 | -1.73811D+05 | -1.64544D+03 | -4.75289D+04   |
| 85     | -1.73811D+05 | -1.64544D+03 | -5.26297D+04   |
| 137 83 | -4.60441D+05 | -7.76230D+01 | -3.98228D+03   |
| 86     | -4.60441D+05 | -7.76230D+01 | -4.22291D+03   |
| 138 84 | -8.97659D+05 | 6.13067D+02  | -4.48937D+04   |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>
OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER
PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3_1
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| NODE    | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|---------|--------------|--------------|----------------|
| 87      | -8.97659D+05 | 6.13067D+02  | -4.29932D+04   |
| 139 85  | -9.01038D+02 | 1.27519D+03  | -2.70142D+03   |
| 86      | -9.01038D+02 | 1.27519D+03  | 2.71813D+03    |
| 140 86  | -9.70429D+02 | -1.29253D+03 | 2.74707D+03    |
| 87      | -9.70429D+02 | -1.29253D+03 | -2.74616D+03   |
| 141 85  | -1.54591D+05 | -8.88766D+02 | -5.03997D+04   |
| 88      | -1.54591D+05 | -8.88766D+02 | -5.31549D+04   |
| 142 86  | -4.42549D+05 | -1.76921D+01 | -4.17546D+03   |
| 89      | -4.42549D+05 | -1.76921D+01 | -4.23031D+03   |
| 143 87  | -8.78518D+05 | 2.27503D+02  | -4.32253D+04   |
| 90      | -8.78518D+05 | 2.27503D+02  | -4.25201D+04   |
| 144 88  | -5.83399D+02 | 9.63477D+02  | -2.04647D+03   |
| 89      | -5.83399D+02 | 9.63477D+02  | 2.04831D+03    |
| 145 89  | -5.56053D+02 | -9.39006D+02 | 1.99543D+03    |
| 90      | -5.56053D+02 | -9.39006D+02 | -1.99534D+03   |
| 146 88  | -1.35708D+05 | -3.95528D+02 | -5.15497D+04   |
| 91      | -1.35708D+05 | -3.95528D+02 | -5.27758D+04   |
| 147 89  | -4.23967D+05 | -3.17186D+01 | -4.13559D+03   |
| 92      | -4.23967D+05 | -3.17186D+01 | -4.23392D+03   |
| 148 90  | -8.59554D+05 | -8.70695D-02 | -4.24364D+04   |
| 93      | -8.59554D+05 | -8.70695D-02 | -4.24367D+04   |
| 149 91  | -1.50247D+02 | 6.38562D+02  | -1.35683D+03   |
| 92      | -1.50247D+02 | 6.38562D+02  | 1.35706D+03    |
| 150 92  | -1.40757D+02 | -5.90184D+02 | 1.25551D+03    |
| 93      | -1.40757D+02 | -5.90184D+02 | -1.25277D+03   |
| 151 91  | -1.17176D+05 | -2.69985D+02 | -5.18299D+04   |
| 94      | -1.17176D+05 | -2.69985D+02 | -5.26669D+04   |
| 152 92  | -4.04687D+05 | -3.34742D+01 | -4.11743D+03   |
| 95      | -4.04687D+05 | -3.34742D+01 | -4.22120D+03   |
| 153 93  | -8.40768D+05 | -6.02033D+01 | -4.20337D+04   |
| 96      | -8.40768D+05 | -6.02033D+01 | -4.22203D+04   |
| 154 94  | 1.23472D+02  | 3.02248D+02  | -6.40767D+02   |
| 95      | 1.23472D+02  | 3.02248D+02  | 6.43789D+02    |
| 155 95  | 1.68088D+02  | -2.42355D+02 | 5.17997D+02    |
| 96      | 1.68088D+02  | -2.42355D+02 | -5.12013D+02   |
| 156 94  | -9.90100D+04 | -3.76687D+02 | -5.24076D+04   |
| 97      | -9.90100D+04 | -3.76687D+02 | -5.35753D+04   |
| 157 95  | -3.84697D+05 | -6.01517D+01 | -4.10338D+03   |
| 98      | -3.84697D+05 | -6.01517D+01 | -4.28985D+03   |
| 158 96  | -8.22164D+05 | 1.75309D+00  | -4.14942D+04   |
| 99      | -8.22164D+05 | 1.75309D+00  | -4.14887D+04   |
| 159 97  | -1.04095D+02 | -6.92996D+01 | 1.53823D+02    |
| 98      | -1.04095D+02 | -6.92996D+01 | -1.40700D+02   |
| 160 98  | -8.68051D+01 | 1.08911D+02  | -2.15305D+02   |
| 99      | -8.68051D+01 | 1.08911D+02  | 2.47569D+02    |
| 161 97  | -8.12477D+04 | -2.85290D+02 | -5.40781D+04   |
| 100     | -8.12477D+04 | -2.85290D+02 | -5.49625D+04   |
| 162 98  | -3.63956D+05 | -6.49675D+01 | -4.23270D+03   |
| 101     | -3.63956D+05 | -6.49675D+01 | -4.43410D+03   |
| 163 99  | -8.69824D+05 | -1.21028D+01 | -4.51112D+04   |
| 102     | -8.69824D+05 | -1.21028D+01 | -4.51487D+04   |
| 164 100 | -7.46707D+02 | -5.20143D+02 | 1.11191D+03    |
| 101     | -7.46707D+02 | -5.20143D+02 | -1.09870D+03   |
| 165 101 | -7.63503D+02 | 6.16376D+02  | -1.29657D+03   |
| 102     | -7.63503D+02 | 6.16376D+02  | 1.32303D+03    |
| 166 100 | -6.39743D+04 | 3.86703D+02  | -5.63812D+04   |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>

OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER

PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

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| NODE    | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|---------|--------------|--------------|----------------|
| 103     | -6.39743D+04 | 3.86703D+02  | -5.51825D+04   |
| 167 101 | -3.42223D+05 | -4.15192D+01 | -4.30918D+03   |
| 104     | -3.42223D+05 | -4.15192D+01 | -4.43789D+03   |
| 168 102 | -8.50159D+05 | -4.47279D+02 | -4.36018D+04   |
| 105     | -8.50159D+05 | -4.47279D+02 | -4.49883D+04   |
| 169 103 | -2.22802D+03 | -1.03175D+03 | 2.21076D+03    |
| 104     | -2.22802D+03 | -1.03175D+03 | -2.17419D+03   |
| 170 104 | -2.27943D+03 | 1.14217D+03  | -2.39655D+03   |
| 105     | -2.27943D+03 | 1.14217D+03  | 2.45769D+03    |
| 171 103 | -4.72564D+04 | 2.37810D+03  | -5.76509D+04   |
| 106     | -4.72564D+04 | 2.37810D+03  | -5.02787D+04   |
| 172 104 | -3.19417D+05 | 1.78585D+01  | -4.32958D+03   |
| 107     | -3.19417D+05 | 1.78585D+01  | -4.27422D+03   |
| 173 105 | -8.30770D+05 | -1.70543D+03 | -4.29058D+04   |
| 108     | -8.30770D+05 | -1.70543D+03 | -4.81927D+04   |
| 174 106 | -5.22790D+03 | -1.55468D+03 | 3.32858D+03    |
| 107     | -5.22790D+03 | -1.55468D+03 | -3.27881D+03   |
| 175 107 | -5.47559D+03 | 1.68598D+03  | -3.54416D+03   |
| 108     | -5.47559D+03 | 1.68598D+03  | 3.62127D+03    |
| 176 106 | -3.11094D+04 | 6.93672D+03  | -5.38155D+04   |
| 109     | -3.11094D+04 | 6.93672D+03  | -3.23117D+04   |
| 177 107 | -2.95512D+05 | 2.01683D+02  | -4.17085D+03   |
| 110     | -2.95512D+05 | 2.01683D+02  | -3.54563D+03   |
| 178 108 | -8.11664D+05 | -4.42095D+03 | -4.55676D+04   |
| 111     | -8.11664D+05 | -4.42095D+03 | -5.92725D+04   |
| 179 109 | -7.33299D+03 | -1.87322D+03 | 3.96988D+03    |
| 110     | -7.33299D+03 | -1.87322D+03 | -3.99132D+03   |
| 180 110 | -4.19760D+03 | 2.25298D+03  | -4.87396D+03   |
| 111     | -4.19760D+03 | 2.25298D+03  | 4.70121D+03    |
| 181 109 | -1.53281D+04 | 1.31711D+04  | -3.64770D+04   |
| 112     | -1.53281D+04 | 1.31711D+04  | 4.35357D+03    |
| 182 110 | -2.70703D+05 | -2.20703D+03 | -3.00487D+03   |
| 113     | -2.70703D+05 | -2.20703D+03 | -9.84669D+03   |
| 183 111 | -7.92840D+05 | -6.18535D+03 | -5.61610D+04   |
| 114     | -7.92840D+05 | -6.18535D+03 | -7.53356D+04   |
| 184 112 | 1.50636D+04  | -2.24213D+03 | 4.11323D+03    |
| 113     | 1.50636D+04  | -2.24213D+03 | -5.41581D+03   |
| 185 113 | 1.05999D+04  | 2.20505D+03  | -4.74842D+03   |
| 114     | 1.05999D+04  | 2.20505D+03  | 4.62304D+03    |
| 186 113 | -2.45587D+05 | 1.25992D+03  | -1.06864D+04   |
| 115     | -2.45587D+05 | 1.25992D+03  | -6.78063D+03   |
| 187 114 | -7.73972D+05 | -8.84796D+02 | -7.23370D+04   |
| 116     | -7.73972D+05 | -8.84796D+02 | -7.50798D+04   |
| 188 115 | 3.18636D+03  | 1.66961D+03  | -3.41609D+03   |
| 116     | 3.18636D+03  | 1.66961D+03  | 3.67977D+03    |
| 189 115 | -2.30622D+05 | -1.29796D+03 | -3.71093D+03   |
| 117     | -2.30622D+05 | -1.29796D+03 | -7.73460D+03   |
| 190 116 | -7.54784D+05 | 8.80062D+02  | -7.26888D+04   |
| 118     | -7.54784D+05 | 8.80062D+02  | -6.99606D+04   |
| 191 117 | -6.05259D+02 | 1.51410D+03  | -3.19160D+03   |
| 118     | -6.05259D+02 | 1.51410D+03  | 3.24331D+03    |
| 192 117 | -2.15830D+05 | -8.37283D+02 | -4.88123D+03   |
| 119     | -2.15830D+05 | -8.37283D+02 | -7.47681D+03   |
| 193 118 | -7.35516D+05 | 5.80802D+02  | -6.78591D+04   |
| 120     | -7.35516D+05 | 5.80802D+02  | -6.60586D+04   |
| 194 119 | -2.38800D+02 | 1.30212D+03  | -2.74742D+03   |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

| NODE    | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|---------|--------------|--------------|----------------|
| 120     | -2.38800D+02 | 1.30212D+03  | 2.78660D+03    |
| 195 119 | -2.01271D+05 | -6.37452D+02 | -5.01550D+03   |
| 121     | -2.01271D+05 | -6.37452D+02 | -6.99160D+03   |
| 196 120 | -7.16147D+05 | 4.36486D+02  | -6.42416D+04   |
| 122     | -7.16147D+05 | 4.36486D+02  | -6.28885D+04   |
| 197 121 | -7.91486D+01 | 1.13913D+03  | -2.40014D+03   |
| 122     | -7.91486D+01 | 1.13913D+03  | 2.44117D+03    |
| 198 121 | -1.86891D+05 | -5.72757D+02 | -4.83912D+03   |
| 123     | -1.86891D+05 | -5.72757D+02 | -6.61467D+03   |
| 199 122 | -6.96711D+05 | 3.90695D+02  | -6.12879D+04   |
| 124     | -6.96711D+05 | 3.90695D+02  | -6.00767D+04   |
| 200 123 | -5.79269D+01 | 1.02912D+03  | -2.16790D+03   |
| 124     | -5.79269D+01 | 1.02912D+03  | 2.20587D+03    |
| 201 123 | -1.72635D+05 | -5.27594D+02 | -4.66924D+03   |
| 125     | -1.72635D+05 | -5.27594D+02 | -6.30478D+03   |
| 202 124 | -6.77244D+05 | 3.60402D+02  | -5.86251D+04   |
| 126     | -6.77244D+05 | 3.60402D+02  | -5.75079D+04   |
| 203 125 | 2.83328D+01  | 9.65109D+02  | -2.03426D+03   |
| 126     | 2.83328D+01  | 9.65109D+02  | 2.06746D+03    |
| 204 125 | -1.58453D+05 | -5.45662D+02 | -4.47960D+03   |
| 127     | -1.58453D+05 | -5.45662D+02 | -6.17116D+03   |
| 205 126 | -6.57780D+05 | 3.68879D+02  | -5.61474D+04   |
| 128     | -6.57780D+05 | 3.68879D+02  | -5.50039D+04   |
| 206 127 | 2.94875D+01  | 9.32518D+02  | -1.95838D+03   |
| 128     | 2.94875D+01  | 9.32518D+02  | 2.00482D+03    |
| 207 127 | -1.44312D+05 | -5.64600D+02 | -4.41299D+03   |
| 129     | -1.44312D+05 | -5.64600D+02 | -6.16325D+03   |
| 208 128 | -6.98788D+05 | 4.00507D+02  | -5.74185D+04   |
| 130     | -6.98788D+05 | 4.00507D+02  | -5.61769D+04   |
| 209 129 | 3.53287D+01  | 1.06054D+03  | -2.23446D+03   |
| 130     | 3.53287D+01  | 1.06054D+03  | 2.27284D+03    |
| 210 129 | -1.30046D+05 | -5.88019D+02 | -4.19113D+03   |
| 131     | -1.30046D+05 | -5.88019D+02 | -6.01399D+03   |
| 211 130 | -6.77636D+05 | 4.13767D+02  | -5.46765D+04   |
| 132     | -6.77636D+05 | 4.13767D+02  | -5.33938D+04   |
| 212 131 | 1.37484D+02  | 1.22775D+03  | -2.58458D+03   |
| 132     | 1.37484D+02  | 1.22775D+03  | 2.63335D+03    |
| 213 131 | -1.15613D+05 | -6.86584D+02 | -3.76278D+03   |
| 133     | -1.15613D+05 | -6.86584D+02 | -5.89119D+03   |
| 214 132 | -6.56640D+05 | 4.76516D+02  | -5.17190D+04   |
| 134     | -6.56640D+05 | 4.76516D+02  | -5.02418D+04   |
| 215 133 | 1.87347D+02  | 1.46402D+03  | -3.08156D+03   |
| 134     | 1.87347D+02  | 1.46402D+03  | 3.14051D+03    |
| 216 133 | -1.00943D+05 | -8.22599D+02 | -3.23884D+03   |
| 135     | -1.00943D+05 | -8.22599D+02 | -5.78889D+03   |
| 217 134 | -6.35856D+05 | 5.64491D+02  | -4.83125D+04   |
| 136     | -6.35856D+05 | 5.64491D+02  | -4.65626D+04   |
| 218 135 | 2.57192D+02  | 1.79144D+03  | -3.77062D+03   |
| 136     | 2.57192D+02  | 1.79144D+03  | 3.84301D+03    |
| 219 135 | -8.59405D+04 | -1.00958D+03 | -2.57779D+03   |
| 137     | -8.59405D+04 | -1.00958D+03 | -5.70749D+03   |
| 220 136 | -6.15355D+05 | 6.85584D+02  | -4.42758D+04   |
| 138     | -6.15355D+05 | 6.85584D+02  | -4.21505D+04   |
| 221 137 | 3.48911D+02  | 2.24119D+03  | -4.71691D+03   |
| 138     | 3.48911D+02  | 2.24119D+03  | 4.80813D+03    |
| 222 137 | -7.04800D+04 | -1.26183D+03 | -1.72851D+03   |



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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

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| NODE    | AXIAL FORCE  | SHEAR FORCE  | BENDING MOMENT |
|---------|--------------|--------------|----------------|
| 139     | -7.04800D+04 | -1.26183D+03 | -5.64020D+03   |
| 223 138 | -5.95234D+05 | 8.47730D+02  | -3.93705D+04   |
| 140     | -5.95234D+05 | 8.47730D+02  | -3.67426D+04   |
| 224 139 | 4.24887D+02  | 2.85545D+03  | -6.00877D+03   |
| 140     | 4.24887D+02  | 2.85545D+03  | 6.12687D+03    |
| 225 139 | -5.43919D+04 | -1.57035D+03 | -6.13366D+02   |
| 141     | -5.43919D+04 | -1.57035D+03 | -5.48143D+03   |
| 226 140 | -5.75628D+05 | 1.04684D+03  | -3.32879D+04   |
| 142     | -5.75628D+05 | 1.04684D+03  | -3.00427D+04   |
| 227 141 | 7.58456D+02  | 3.70437D+03  | -7.80387D+03   |
| 142     | 7.58456D+02  | 3.70437D+03  | 7.93969D+03    |
| 228 141 | -3.74346D+04 | -2.13781D+03 | 9.99957D+02    |
| 143     | -3.74346D+04 | -2.13781D+03 | -5.62726D+03   |
| 229 142 | -5.56742D+05 | 1.42563D+03  | -2.56600D+04   |
| 144     | -5.56742D+05 | 1.42563D+03  | -2.12405D+04   |
| 230 143 | 2.82639D+03  | 4.87020D+03  | -1.02772D+04   |
| 144     | 2.82639D+03  | 4.87020D+03  | 1.04212D+04    |
| 231 143 | -1.92811D+04 | -4.18240D+03 | 2.85392D+03    |
| 145     | -1.92811D+04 | -4.18240D+03 | -1.01115D+04   |
| 232 144 | -5.38882D+05 | 2.73642D+03  | -1.55881D+04   |
| 146     | -5.38882D+05 | 2.73642D+03  | -7.10522D+03   |
| 233 145 | -5.68626D+03 | 5.99058D+03  | -1.22791D+04   |
| 146     | -5.68626D+03 | 5.99058D+03  | 1.31808D+04    |

  
 ศูนย์วิทยทรัพยากร  
 จุฬาลงกรณ์มหาวิทยาลัย

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

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 => COMBINATION JOINT DISPLACEMENT : INSTANTANEOUS + TIME DEPENDENT  
 => AT SEQUENCE 1 TO 69 : END OF TIME 3650 DAYS  
 =====

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION      |
|------|--------------|---------------|---------------|
| 1    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00  |
| 2    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00  |
| 3    | 0.000000D+00 | 0.000000D+00  | 0.000000D+00  |
| 4    | 9.689008D-05 | -7.468198D-04 | -4.871562D-05 |
| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION      |
| 5    | 9.705556D-05 | -9.922395D-04 | -4.776102D-05 |
| 6    | 9.704848D-05 | -1.113362D-03 | -4.840138D-05 |
| 7    | 3.912869D-04 | -1.441781D-03 | -9.867917D-05 |
| 8    | 3.914068D-04 | -1.940280D-03 | -9.777100D-05 |
| 9    | 3.915935D-04 | -2.236393D-03 | -9.860601D-05 |
| 10   | 8.889644D-04 | -2.094203D-03 | -1.496442D-04 |
| 11   | 8.891972D-04 | -2.853287D-03 | -1.487398D-04 |
| 12   | 8.896637D-04 | -3.334942D-03 | -1.493607D-04 |
| 13   | 1.596646D-03 | -2.701458D-03 | -2.014452D-04 |
| 14   | 1.596745D-03 | -3.729608D-03 | -2.007826D-04 |
| 15   | 1.597092D-03 | -4.408156D-03 | -2.008953D-04 |
| 16   | 2.521832D-03 | -3.262819D-03 | -2.537789D-04 |
| 17   | 2.521843D-03 | -4.569361D-03 | -2.535056D-04 |
| 18   | 2.521846D-03 | -5.455820D-03 | -2.532992D-04 |
| 19   | 4.161864D-03 | -4.103211D-03 | -3.268818D-04 |
| 20   | 4.161860D-03 | -5.807846D-03 | -3.259709D-04 |
| 21   | 4.162613D-03 | -6.904093D-03 | -3.260045D-04 |
| 22   | 5.290617D-03 | -4.483548D-03 | -3.681875D-04 |
| 23   | 5.291512D-03 | -6.427856D-03 | -3.695182D-04 |
| 24   | 5.292355D-03 | -7.672041D-03 | -3.689622D-04 |
| 25   | 6.578848D-03 | -4.877972D-03 | -4.150761D-04 |
| 26   | 6.580430D-03 | -7.022915D-03 | -4.138766D-04 |
| 27   | 6.581378D-03 | -8.421588D-03 | -4.136896D-04 |
| 28   | 8.038380D-03 | -5.233235D-03 | -4.614824D-04 |
| 29   | 8.038487D-03 | -7.593568D-03 | -4.600894D-04 |
| 30   | 8.038683D-03 | -9.152793D-03 | -4.599728D-04 |
| 31   | 9.672793D-03 | -5.549430D-03 | -5.080277D-04 |
| 32   | 9.673090D-03 | -8.140493D-03 | -5.079524D-04 |
| 33   | 9.672685D-03 | -9.865746D-03 | -5.077941D-04 |
| 34   | 1.149191D-02 | -5.909925D-03 | -5.584538D-04 |
| 35   | 1.149253D-02 | -8.665764D-03 | -5.557600D-04 |
| 36   | 1.149234D-02 | -1.056059D-02 | -5.574769D-04 |
| 37   | 1.350806D-02 | -6.227140D-03 | -6.099118D-04 |
| 38   | 1.350815D-02 | -9.169255D-03 | -6.077628D-04 |
| 39   | 1.350790D-02 | -1.130085D-02 | -6.089558D-04 |
| 40   | 1.567534D-02 | -6.527012D-03 | -6.613055D-04 |
| 41   | 1.567543D-02 | -9.670196D-03 | -6.585989D-04 |
| 42   | 1.567520D-02 | -1.202960D-02 | -6.609367D-04 |
| 43   | 1.805331D-02 | -6.814789D-03 | -7.163388D-04 |
| 44   | 1.805343D-02 | -1.017537D-02 | -7.130438D-04 |
| 45   | 1.805333D-02 | -1.273159D-02 | -7.155539D-04 |
| 46   | 2.085168D-02 | -7.088877D-03 | -7.781057D-04 |
| 47   | 2.085171D-02 | -1.070546D-02 | -7.736226D-04 |
| 48   | 2.085103D-02 | -1.347728D-02 | -7.770495D-04 |
| 49   | 2.387758D-02 | -7.289996D-03 | -8.421397D-04 |
| 50   | 2.387663D-02 | -1.117290D-02 | -8.365232D-04 |
| 51   | 2.387595D-02 | -1.416731D-02 | -8.410606D-04 |
| 52   | 2.832683D-02 | -7.611706D-03 | -9.312785D-04 |
| 53   | 2.832713D-02 | -1.186346D-02 | -9.220693D-04 |

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<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

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| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION      |
|------|--------------|---------------|---------------|
| 54   | 2.832644D-02 | -1.515276D-02 | -9.303230D-04 |
| 55   | 3.266781D-02 | -7.791946D-03 | -1.018327D-03 |
| 56   | 3.266608D-02 | -1.242357D-02 | -1.010030D-03 |
| 57   | 3.266640D-02 | -1.612211D-02 | -1.016730D-03 |
| 58   | 3.981712D-02 | -8.168907D-03 | -1.151430D-03 |
| 59   | 3.981663D-02 | -1.338222D-02 | -1.141922D-03 |
| 60   | 3.981605D-02 | -1.766808D-02 | -1.149686D-03 |
| 61   | 4.792248D-02 | -8.441269D-03 | -1.290409D-03 |
| 62   | 4.792294D-02 | -1.427499D-02 | -1.281403D-03 |
| 63   | 4.792436D-02 | -1.915667D-02 | -1.290243D-03 |
| 64   | 5.976171D-02 | -8.415859D-03 | -1.483942D-03 |
| 65   | 5.976622D-02 | -1.512078D-02 | -1.473495D-03 |
| 66   | 5.976852D-02 | -2.077102D-02 | -1.480215D-03 |
| 67   | 6.515805D-02 | -8.178981D-03 | -1.569402D-03 |
| 68   | 6.515773D-02 | -1.527432D-02 | -1.565505D-03 |
| 69   | 6.515879D-02 | -2.135071D-02 | -1.566332D-03 |
| 70   | 7.039520D-02 | -8.031375D-03 | -1.647280D-03 |
| 71   | 7.039447D-02 | -1.545989D-02 | -1.644232D-03 |
| 72   | 7.039419D-02 | -2.191620D-02 | -1.645194D-03 |
| 73   | 7.579904D-02 | -7.867476D-03 | -1.724786D-03 |
| 74   | 7.579886D-02 | -1.562053D-02 | -1.722603D-03 |
| 75   | 7.579905D-02 | -2.244761D-02 | -1.723422D-03 |
| 76   | 8.141343D-02 | -7.675411D-03 | -1.802543D-03 |
| 77   | 8.141479D-02 | -1.575039D-02 | -1.801033D-03 |
| 78   | 8.141640D-02 | -2.294354D-02 | -1.801764D-03 |
| 79   | 8.725629D-02 | -7.451170D-03 | -1.881687D-03 |
| 80   | 8.725887D-02 | -1.584743D-02 | -1.879618D-03 |
| 81   | 8.726214D-02 | -2.340375D-02 | -1.879907D-03 |
| 82   | 9.334377D-02 | -7.192937D-03 | -1.964953D-03 |
| 83   | 9.334280D-02 | -1.591059D-02 | -1.961222D-03 |
| 84   | 9.334198D-02 | -2.382822D-02 | -1.956599D-03 |
| 85   | 9.969694D-02 | -6.899810D-03 | -2.053956D-03 |
| 86   | 9.969265D-02 | -1.593914D-02 | -2.052587D-03 |
| 87   | 9.968804D-02 | -2.434606D-02 | -2.052474D-03 |
| 88   | 1.063340D-01 | -6.571449D-03 | -2.146685D-03 |
| 89   | 1.063312D-01 | -1.593183D-02 | -2.146515D-03 |
| 90   | 1.063286D-01 | -2.482427D-02 | -2.146457D-03 |
| 91   | 1.132631D-01 | -6.207786D-03 | -2.240279D-03 |
| 92   | 1.132623D-01 | -1.588746D-02 | -2.240246D-03 |
| 93   | 1.132616D-01 | -2.526286D-02 | -2.239966D-03 |
| 94   | 1.204859D-01 | -5.808886D-03 | -2.333981D-03 |
| 95   | 1.204864D-01 | -1.580486D-02 | -2.333736D-03 |
| 96   | 1.204872D-01 | -2.566191D-02 | -2.333192D-03 |
| 97   | 1.280046D-01 | -5.374888D-03 | -2.428956D-03 |
| 98   | 1.280041D-01 | -1.568290D-02 | -2.427920D-03 |
| 99   | 1.280036D-01 | -2.602155D-02 | -2.425264D-03 |
| 100  | 1.358259D-01 | -4.906007D-03 | -2.526686D-03 |
| 101  | 1.358224D-01 | -1.552045D-02 | -2.525688D-03 |
| 102  | 1.358188D-01 | -2.639937D-02 | -2.523513D-03 |
| 103  | 1.439584D-01 | -4.402574D-03 | -2.627022D-03 |
| 104  | 1.439480D-01 | -1.531599D-02 | -2.624187D-03 |
| 105  | 1.439374D-01 | -2.673605D-02 | -2.619227D-03 |
| 106  | 1.524041D-01 | -3.864988D-03 | -2.725359D-03 |
| 107  | 1.523797D-01 | -1.506795D-02 | -2.721464D-03 |
| 108  | 1.523542D-01 | -2.703178D-02 | -2.715146D-03 |
| 109  | 1.611359D-01 | -3.293660D-03 | -2.805975D-03 |

<< THESIS : TIME DEPENDENT ANALYSIS OF AXIAL SHORTENING OF CONCRETE COMPOSITE COLUMNS WITH STAGE CONSTRUCTION >>  
 OFFICE : PROJECT# ENGINEER : CIVIL ENGINEER  
 PROJECT : COLUMN SHORTENING DATE : 04-27-1994 FILE : DATA\baiy3\_1

| NODE | X-MOVEMENT   | Y-MOVEMENT    | ROTATION      |
|------|--------------|---------------|---------------|
| 110  | 1.611014D-01 | -1.477467D-02 | -2.807663D-03 |
| 111  | 1.610817D-01 | -2.728680D-02 | -2.821221D-03 |
| 112  | 1.700531D-01 | -2.688740D-03 | -2.837660D-03 |
| 113  | 1.701236D-01 | -1.443474D-02 | -2.942127D-03 |
| 114  | 1.701730D-01 | -2.750138D-02 | -2.951446D-03 |
| 115  | 1.775270D-01 | -1.419836D-02 | -3.088257D-03 |
| 116  | 1.775419D-01 | -2.767974D-02 | -3.067248D-03 |
| 117  | 1.842072D-01 | -1.399392D-02 | -3.169450D-03 |
| 118  | 1.842043D-01 | -2.781920D-02 | -3.165311D-03 |
| 119  | 1.907161D-01 | -1.377667D-02 | -3.255466D-03 |
| 120  | 1.907149D-01 | -2.791878D-02 | -3.252301D-03 |
| 121  | 1.971452D-01 | -1.353873D-02 | -3.334732D-03 |
| 122  | 1.971448D-01 | -2.797822D-02 | -3.331416D-03 |
| 123  | 2.035132D-01 | -1.327666D-02 | -3.407045D-03 |
| 124  | 2.035129D-01 | -2.799736D-02 | -3.403971D-03 |
| 125  | 2.098210D-01 | -1.298849D-02 | -3.473347D-03 |
| 126  | 2.098211D-01 | -2.797608D-02 | -3.470654D-03 |
| 127  | 2.160633D-01 | -1.267299D-02 | -3.535533D-03 |
| 128  | 2.160634D-01 | -2.791429D-02 | -3.531773D-03 |
| 129  | 2.222392D-01 | -1.232928D-02 | -3.597057D-03 |
| 130  | 2.222394D-01 | -2.786382D-02 | -3.593943D-03 |
| 131  | 2.283434D-01 | -1.195647D-02 | -3.653839D-03 |
| 132  | 2.283441D-01 | -2.777024D-02 | -3.649885D-03 |
| 133  | 2.343572D-01 | -1.155380D-02 | -3.703581D-03 |
| 134  | 2.343581D-01 | -2.763348D-02 | -3.698804D-03 |
| 135  | 2.402560D-01 | -1.112052D-02 | -3.745329D-03 |
| 136  | 2.402572D-01 | -2.745353D-02 | -3.739467D-03 |
| 137  | 2.460106D-01 | -1.065584D-02 | -3.777581D-03 |
| 138  | 2.460123D-01 | -2.723045D-02 | -3.770198D-03 |
| 139  | 2.515849D-01 | -1.015884D-02 | -3.798265D-03 |
| 140  | 2.515869D-01 | -2.696436D-02 | -3.788700D-03 |
| 141  | 2.569325D-01 | -9.628417D-03 | -3.802958D-03 |
| 142  | 2.569360D-01 | -2.665544D-02 | -3.791930D-03 |
| 143  | 2.619899D-01 | -9.063165D-03 | -3.787184D-03 |
| 144  | 2.620032D-01 | -2.630399D-02 | -3.775568D-03 |
| 145  | 2.667386D-01 | -8.461254D-03 | -3.802964D-03 |
| 146  | 2.667118D-01 | -2.591036D-02 | -3.730175D-03 |

จุฬาลงกรณ์มหาวิทยาลัย

ภาคผนวก ข

รายละเอียดการทำงานของโปรแกรมคอมพิวเตอร์



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

### รายละเอียดการทำงานของโปรแกรมคอมพิวเตอร์

โปรแกรมคอมพิวเตอร์สำหรับในงานวิจัยนี้ได้พัฒนามาจากโปรแกรม CUSANAP ที่ใช้สำหรับวิเคราะห์โครงสร้างระนาบ 2 มิติที่รับน้ำหนักบรรทุกคงที่ที่กระทำกันที่ทันใด ซึ่งโปรแกรมนี้จะใช้ภาษา QBASIC รุ่น 4.5 ส่วนการทำงานที่แตกต่างจากโปรแกรมเดิมกับในงานวิจัยนี้คือ การวิเคราะห์ที่พิจารณาผลของการปรับแก้ระดับและการวิเคราะห์โครงสร้างให้เป็นไปตามขั้นตอนการก่อสร้าง นอกจากนี้ยังต้องคำนึงถึงการพิจารณาผลเชิงเวลา ( การคืบ (Creep) และการหดตัวที่สูญเสียความชื้น (Shrinkage) ) , เวลาและขั้นตอนในการก่อสร้าง ซึ่งจะมีผลโดยตรงต่อคุณสมบัติของคอนกรีต

#### 1. ไฟล์ที่ใช้ในโปรแกรม

ไฟล์ใช้งานที่ได้หลังจากคอมไพล์โปรแกรมแล้วที่ให้อยู่ในงานวิจัยจะแบ่งออกเป็น 2 ส่วนคือ ไฟล์ปฏิบัติการ และไฟล์เก็บข้อมูล

##### 1.1 ไฟล์ปฏิบัติการ ประกอบไปด้วย

|             |              |              |
|-------------|--------------|--------------|
| INPUT.EXE   | FRAME.OBJ    | PLOT.DFT     |
| FRAME.EXE   | FEM.OBJ      | CUANDES.DFT  |
| GRSANAP.EXE | FORCE.OBJ    | GRAPHICS.COM |
| BC.EXE      | PRINT.OBJ    | GRAPHICS.PRO |
| BRUN45.EXE  | RELAX1.OBJ   | MSHERC.COM   |
| LIB.EXE     | RWSANAP.OBJ  |              |
| LINK.EXE    | SKYLINE.OBJ  |              |
|             | STIFF-2D.OBJ |              |
|             | TOOLS.OBJ    |              |
|             | FILEINFO.OBJ |              |
|             | INPUT.OBJ    |              |
|             | PRINTOUT.OBJ |              |
|             | PLOT.OBJ     |              |

##### 1.2 ไฟล์เก็บข้อมูล

ลักษณะการเก็บข้อมูลของโปรแกรมจะใช้วิธีบันทึกลงไฟล์ในซับไดเรกทอรี (Subdirectories) "DATA" โดยลักษณะของไฟล์ที่เก็บจะแยกออกเป็นส่วนของข้อมูลดิบ (Raw data) และส่วนผลลัพธ์ของข้อมูล ซึ่งจะแยกประเภทตามนามสกุลที่ใช้ดังต่อไปนี้

ไฟล์ข้อมูลดิบ ประกอบด้วยชื่อไฟล์ที่มีนามสกุลต่อท้าย คือ

\* GEO เป็นไฟล์ที่ใช้เก็บข้อมูลที่เกี่ยวข้องกับลักษณะรูปร่างโดยรวมของโครงสร้าง ตลอดจนคุณสมบัติต่าง ๆ ของวัสดุในชิ้นส่วน

\* SEQ เป็นไฟล์ที่เกี่ยวข้องกับข้อมูลของขั้นตอนการก่อสร้างตามเวลาที่กำหนด

\* LDS เป็นไฟล์ที่เก็บข้อมูลของน้ำหนักบรรทุกกระทำในแต่ละขั้นตอนของการก่อสร้าง

\* COD เป็นไฟล์ที่เก็บข้อมูลค่าคงที่ที่นำไปใช้คำนวณค่าตัวประกอบปรับแก้สัมประสิทธิ์การคืบ และความเครียดหดตัว ตามข้อกำหนดของ ACI 209 (1985)

ไฟล์เก็บผลลัพธ์ของข้อมูล

\* SFS เป็นไฟล์เก็บค่าสถิติโดยรวมของเหล็กเสริมที่เพิ่มขึ้นตามขั้นตอนการก่อสร้าง

\* STF เป็นไฟล์เก็บค่าสถิติโดยรวมของคอนกรีตที่เพิ่มขึ้นตามขั้นตอนการก่อสร้าง

\* DSF เป็นไบนารีไฟล์ที่ใช้เก็บข้อมูลตำแหน่งการเปลี่ยนแปลงของตัวรวมทั้งหมด เพื่อนำไปแสดงเป็นภาพการเสียรูปของโครงสร้าง และไดอะแกรมของแรงตามแนวแกน

\* BSD เป็นไบนารีไฟล์ที่ใช้เก็บข้อมูลแรงภายในชิ้นส่วนของโครงสร้างทั้งหมด เพื่อนำไปแสดงเป็นภาพไดอะแกรมโมเมนต์ดัด และไดอะแกรมของแรงเฉือน

\* DIS เป็นไบนารีไฟล์ที่ใช้เก็บข้อมูลของการเปลี่ยนแปลงของตัวรวมทั้งขั้นตอนการก่อสร้าง

\* STR เป็นไบนารีไฟล์ที่ใช้เก็บข้อมูลแรงภายในชิ้นส่วนของโครงสร้างรวมทั้งขั้นตอนการก่อสร้าง

\* S\* เป็นไฟล์ที่เก็บข้อมูลแรงภายในชิ้นส่วนของโครงสร้างช่วงอีลาस्टิกในแต่ละขั้นตอนของการก่อสร้าง

\* C\* เป็นไฟล์ที่เก็บข้อมูลแรงภายในชิ้นส่วนคอนกรีตของโครงสร้างช่วงอีลาस्टิกในแต่ละขั้นตอนของการก่อสร้าง

\* Y\* เป็นไฟล์ที่เก็บข้อมูลแรงภายในชิ้นส่วนเหล็กเสริมของโครงสร้างช่วงอีลาस्टิกในแต่ละขั้นตอนของการก่อสร้าง

\* T\* เป็นไฟล์ที่เก็บข้อมูลแรงภายในชิ้นส่วนของโครงสร้างช่วงคิดผลเชิงเวลาในแต่ละขั้นตอนของการก่อสร้าง

\* B\* เป็นไฟล์ที่เก็บข้อมูลแรงภายในชิ้นส่วนคอนกรีตของโครงสร้างช่วงคิดผลเชิงเวลาในแต่ละขั้นตอนของการก่อสร้าง

\* Z\* เป็นไฟล์ที่เก็บข้อมูลแรงภายในชิ้นส่วนเหล็กเสริมของโครงสร้างช่วงคิดผลเชิงเวลาในแต่ละขั้นตอนของการก่อสร้าง

\* U\* เป็นไฟล์ที่เก็บข้อมูลค่าการเปลี่ยนแปลงตำแหน่งของจุดต่อในแต่ละชิ้นส่วนของโครงสร้างช่วงอีลาस्टิกในแต่ละขั้นตอนของการก่อสร้าง

\* W\* เป็นไฟล์ที่เก็บข้อมูลค่าการเปลี่ยนแปลงตำแหน่งของจุดต่อในแต่ละชิ้นส่วนของโครงสร้างช่วงคิดผลเชิงเวลาในแต่ละขั้นตอนของการก่อสร้าง

เครื่องหมาย \* ด้านหน้าจะบอกถึงชื่อไฟล์ข้อมูลใด ๆ ส่วนเครื่องหมาย \* ด้านหลังนามสกุลจะบอกถึงหมายเลขขั้นตอนของการก่อสร้างที่พิจารณา

## 2. ข้อมูลเบื้องต้นของโปรแกรมคอมพิวเตอร์

ข้อมูลที่ใช้ในโปรแกรมคอมพิวเตอร์ ประกอบไปด้วย

### 2.1 ข้อมูลทั่วไป

- 2.1.1 รายละเอียดโดยทั่วไปของไฟล์ที่จะวิเคราะห์
- 2.1.2 จำนวนขั้นตอนการก่อสร้างทั้งหมด
- 2.1.3 จำนวนข้อต่อทั้งหมด
- 2.1.4 จำนวนชิ้นส่วนทั้งหมด
- 2.1.5 จำนวนชนิดของวัสดุทั้งหมด
- 2.1.6 จำนวนจุดรองรับทั้งหมด
- 2.1.7 เวลาสุดท้ายที่ใช้วิเคราะห์

### 2.2 ข้อมูลข้อต่อ

- 2.2.1 การระบุหมายเลขของข้อต่อ
- 2.2.2 ตำแหน่งพิกัดของข้อต่อ

### 2.3 ข้อมูลชิ้นส่วน

- 2.3.1 การระบุหมายเลขของชิ้นส่วน
- 2.3.2 ความสัมพันธ์เชื่อมโยงของจุดต่อในชิ้นส่วนที่ปลายทั้งสองข้าง (  $i$  และ  $j$  )
- 2.3.3 หมายเลขชนิดวัสดุของชิ้นส่วน
- 2.3.4 วันที่เริ่มหล่อคอนกรีต ( วัน )
- 2.3.5 การพิจารณาผลของการคืบ
- 2.3.6 การพิจารณาผลของการหดตัวจากการสูญเสียความชื้น

### 2.4 ข้อมูลคุณสมบัติของวัสดุ

- 2.4.1 หมายเลขชนิดของวัสดุ
- 2.4.2 โมดูลัสยืดหยุ่นของคอนกรีตที่อายุ 28 วัน
- 2.4.3 พื้นที่หน้าตัดของคอนกรีต
- 2.4.4 โมเมนต์ความเฉื่อยของคอนกรีต
- 2.4.5 ค่า G
- 2.4.6 ค่า BETA
- 2.4.7 โมดูลัสยืดหยุ่นของเหล็กเสริม
- 2.4.8 โมเมนต์ความเฉื่อยของเหล็กเสริม

2.5 ข้อมูลสภาพการยึดรั้งของจุดรองรับ ถ้ามีการยึดรั้งไม่ให้จุดต่อมีการเคลื่อนที่จะใช้สัญลักษณ์ " R " ( Restraint ) และให้มีการเคลื่อนที่ของจุดต่ออย่างอิสระในทิศทางใด ๆ จะใช้ " U " ( Unrestraint )

### 2.6 ข้อมูลขั้นตอนในการก่อสร้าง

- 2.6.1 หมายเลขขั้นตอนการก่อสร้างที่พิจารณา
- 2.6.2 วันที่ของการก่อสร้างโครงสร้างตามขั้นตอนที่กำหนดให้สามารถรับน้ำหนักได้ ( วัน )



2.6.3 จำนวนจุดต่อ, ชิ้นส่วน และชนิดของวัสดุทั้งหมด

2.6.4 หมายเลขชิ้นส่วนของโครงสร้างนำมาพิจารณาตามขั้นตอนการก่อสร้างทั้งหมด

2.7 ข้อมูลน้ำหนักบรรทุกคงที่กระทำต่อโครงสร้าง

2.7.1 หมายเลขขั้นตอนการก่อสร้างที่พิจารณา

2.7.2 จำนวนจุดต่อทั้งหมดที่มีน้ำหนักกระทำคงค้าง

2.7.3 ตำแหน่งของจุดต่อ และขนาดของน้ำหนักที่มากระทำต่อโครงสร้าง

### 3. การทำงานของโปรแกรม

ในรายละเอียดการทำงานของโปรแกรมสามารถจะแบ่งออกเป็น 4 ส่วนคือ

3.1 การป้อนข้อมูล

3.2 การประมวลผลข้อมูล

3.3 การแสดงผลข้อมูล

3.4 การแสดงรูปภาพ

3.1 การป้อนข้อมูล ข้อมูลที่โปรแกรมจะใช้ในการวิเคราะห์โครงสร้างได้อธิบายไว้แล้วในหัวข้อที่แล้ว การทำงานจะอยู่ภายใต้ไฟล์ชื่อ INPUT.EXE หรือ INPUT.BAS ส่วนการบันทึกไฟล์ข้อมูลจะเป็นแบบไฟล์ข้อความ (Text File) ทั้งหมด

3.2 การประมวลผลข้อมูล หลังจากที่ป้อนและบันทึกข้อมูลเรียบร้อยแล้ว เมื่อผู้ใช้เข้าสู่ส่วนประมวลผลของข้อมูล ซึ่งทำงานอยู่ภายใต้ไฟล์ชื่อ FRAME.EXE หรือ FRAME.BAS โดยในส่วนนี้จะอ้างอิงถึงการป้อนข้อมูลของมาตรฐาน ACI 209 ซึ่งจะเกี่ยวข้องกับพารามิเตอร์การคืบ และการหดตัวจากการสูญเสียความชื้นที่เกิดขึ้นตามเวลาในการก่อสร้าง ค่าตัวแปรต่าง ๆ ที่กำหนดไว้ในโปรแกรมจะเป็นค่าปกติทั่ว ๆ ไปที่ใช้แต่ผู้ใช้สามารถเปลี่ยนแปลงค่าเหล่านี้ได้ วิธีการวิเคราะห์โครงสร้างใช้หลักการสตีฟเนสโดยตรง (Direct stiffness method) ดังได้กล่าวไว้แล้วในบทที่ 3 การประมวลผลของไฟล์นี้จะแยกออกเป็น 2 ส่วนคือ

3.2.1 การวิเคราะห์ในช่วงของอีลาสติก (Elastic analysis)

1 คำนวณสตีฟเนสของระบบโคออร์ดิเนตของทุกชิ้นส่วนทั้งคอนกรีต และเหล็กเสริมแล้วนำไปแยกเก็บไว้ที่ไฟล์นามสกุล \*.STF และ \*.SFS ตามลำดับ เป็นไฟล์ข้อความ (Text file) โดยยังไม่คูณค่าโมดูลัสยืดหยุ่น

2 รวมค่าสตีฟเนสเมตริกส์ของทั้งคอนกรีต และเหล็กเสริมที่คูณค่าโมดูลัส ( $E_c$  และ  $E_s$ ) แล้วเข้าด้วยกัน

3 จัดเรียงสตีฟเนสเมตริกส์เก็บไว้ในตัวแปร 1 มิติ (1 - D Array) ในระบบของโกลบัลโคออร์ดิเนต (ไฟล์ SKYLINE.BAS : SKYDIRECT)

4 สังเคราะห์สตีฟเนสที่จัดเก็บไว้แล้วตามขั้นตอนการก่อสร้าง โดยที่ขนาดสตีฟเนสในแต่ละขั้นตอนจะถูกกำหนดจากโครงสร้างในขั้นตอนสุดท้ายตลอด (ไฟล์ SKYLINE.BAS : SKYFAC)

5 คำนวณสถิติในสมมติฐานของแรงยึดรั้งในชิ้นส่วน

6 ทำการขจัดโดยวิธีของเกาส์ ( Gauss elimination ) แต่จะกระโดดข้ามไปในกรณีที่มีค่าในแนวทแยงของสถิติในสมมติฐานที่มีค่าเป็นศูนย์ ( ไฟล์ SKYLINE.BAS : SKYSOL )

### 3.2.2 การวิเคราะห์ในช่วงผลเชิงเวลา

1 คำนวณค่าสัมประสิทธิ์การคืบ , การหดตัวจากการสูญเสียความชื้น และสัมประสิทธิ์อายุ

2 คำนวณค่าโมดูลัสปรับแก้อายุเฉลี่ยที่เปลี่ยนแปลงไปตามเวลาการก่อสร้างโดยพิจารณาจากสัมประสิทธิ์การคืบ และสัมประสิทธิ์อายุเป็นค่าเฉลี่ยในช่วงเวลาที่วิเคราะห์

3 คำนวณค่าแรงยึดรั้งในชิ้นส่วนจากผลเชิงเวลา

4 สังเคราะห์สถิติในสมมติฐานของโครงสร้างเชิงเวลาของระบบโกลบอลโคออร์ดิเนตในแต่ละขั้นตอน โดยใช้สถิติในสมมติฐานย่อยของชิ้นส่วนที่เก็บไว้ในไฟล์ \*.STF และ \*.SFS ตามลำดับ ควบคุมด้วยโมดูลัสปรับแก้ อายุ และโมดูลัสของเหล็กเสริม ( ขนาดของสถิติในในแต่ละขั้นตอนที่ได้จะมีขนาดเท่ากับโครงสร้างในขั้นตอนสุดท้าย ) ( ไฟล์ SKYLINE.BAS : SKYFAC )

5 ทำการขจัดโดยวิธีของเกาส์ ( Gauss elimination ) แต่จะกระโดดข้ามไปในกรณีที่มีค่าในแนวทแยงของสถิติในสมมติฐานที่มีค่าเป็นศูนย์ ( ไฟล์ SKYLINE.BAS : SKYSOL )

3.3 การแสดงผลข้อมูล ทำงานอยู่ภายใต้ไฟล์ชื่อ ( PRINT.BAS : PRINTRESULTS ) ผลลัพธ์ที่ได้รับการวิเคราะห์จะมีการนำเสนอใน 3 ลักษณะใหญ่ ๆ คือ การแสดงผลในช่วงอีลาสติก ( Elastic or instantaneous ) , การแสดงผลในช่วงเชิงเวลา ( Time dependent ) และการแสดงผลรวมของทั้งอีลาสติก และจากผลเชิงเวลา โดยที่ในแต่ละแบบจะสามารถแสดงผลเฉพาะในแต่ละขั้นตอนของเวลาการก่อสร้าง หรือจะรวมผลลัพธ์ของทุกขั้นตอนการก่อสร้างได้เช่นกัน ผลลัพธ์ที่จะแสดงรายละเอียดประกอบไปด้วย

3.3.1 แรงภายในของชิ้นส่วน ( แรงอัด , แรงเฉือน และโมเมนต์ดัด )

3.3.2 การเคลื่อนที่ของจุดต่อตามแนวราบ , แนวตั้ง และการหมุนที่ข้อของโครงสร้าง

3.3.3 แรงปฏิกิริยาที่ฐานรองรับ

3.4 การแสดงรูปภาพ ทำงานอยู่ภายใต้ไฟล์ชื่อ GRSANAP.EXE หรือ GRSANAP.BAS ซึ่งใช้แสดงผลลัพธ์ของโครงสร้างออกทั้งทางจอภาพ ( Screen ) และทางเครื่องพิมพ์ ( Printer ) รูปแบบจอภาพที่จะแสดงประกอบไปด้วย

3.4.1 ลักษณะของโครงสร้างที่จะวิเคราะห์

3.4.2 ลักษณะเสียรูปว่างของโครงสร้าง

3.4.3 ลักษณะไดอะแกรมของแรงอัด

3.4.4 ลักษณะไดอะแกรมของแรงเฉือน

3.4.5 ลักษณะไดอะแกรมของโมเมนต์ดัด

## ประวัติผู้เขียน

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 ปริญญาวิศวกรรมศาสตรบัณฑิต สาขาวิศวกรรมโยธา ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์ จาก  
 สถาบันเทคโนโลยีพระจอมเกล้า ธนบุรี เมื่อปีการศึกษา 2535 และได้เข้ารับการศึกษาระดับปริญญาวิศวกรรม-  
 ศาสตรมหาบัณฑิต ณ บัณฑิตวิทยาลัยจุฬาลงกรณ์มหาวิทยาลัย ในปีการศึกษา 2536



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