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16 / ENG031030

Civil Engineering

ENG 382

Assignment 3

$$\bar{T}_1 + \bar{T}_2 - 2\bar{T}_3 + \bar{T}_4 + 3\bar{T}_5 - \bar{T}_6 = 4$$

$$2\bar{T}_1 - \bar{T}_2 + \bar{T}_3 + 2\bar{T}_4 + \bar{T}_5 - 3\bar{T}_6 = 20$$

$$\bar{T}_1 + 3\bar{T}_2 - 3\bar{T}_3 - \bar{T}_4 + 2\bar{T}_5 + \bar{T}_6 = -15$$

$$5\bar{T}_1 + 2\bar{T}_2 - \bar{T}_3 - \bar{T}_4 + 2\bar{T}_5 + \bar{T}_6 = -3$$

$$-3\bar{T}_1 - \bar{T}_2 + 2\bar{T}_3 + 3\bar{T}_4 + \bar{T}_5 + 3\bar{T}_6 = 16$$

$$4\bar{T}_1 + 3\bar{T}_2 + \bar{T}_3 - 6\bar{T}_4 - 3\bar{T}_5 - 2\bar{T}_6 = -27$$

Solution

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 2 & -1 & 1 & 2 & 1 & -3 \\ 1 & 3 & -3 & -1 & 2 & 1 \\ 5 & 2 & -1 & -1 & 2 & 1 \\ -3 & -1 & 2 & 3 & 1 & 3 \\ 4 & 3 & 1 & 6 & -3 & -2 \end{bmatrix} \begin{bmatrix} \bar{T}_1 \\ \bar{T}_2 \\ \bar{T}_3 \\ \bar{T}_4 \\ \bar{T}_5 \\ \bar{T}_6 \end{bmatrix} = \begin{bmatrix} 4 \\ 20 \\ -15 \\ -3 \\ 16 \\ -27 \end{bmatrix}$$

$$\bar{T}_1 = 2$$

$$\bar{T}_2 = 1$$

$$\bar{T}_3 = 5$$

$$\bar{T}_4 = -3$$

$$\bar{T}_5 = 4$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 2-2(1) & -1-2(1) & 1-2(-2) & 2-2(1) & 1-2(3) & -3-2(-1) \\ 1-1(1) & 3-1(1) & -3-1(-2) & -1-1(1) & 2-1(3) & 1-1(-1) \\ 5-5(1) & 2-5(1) & -1-5(-2) & -1-5(1) & 2-5(3) & 1-5(-1) \\ -3+3(1) & -1+3(1) & 2+3(-2) & 3+3(1) & 1+3(3) & 3+3(-1) \\ 4-4(1) & 3-4(1) & 1-4(-2) & -6-4(1) & 3-4(3) & -2-4(-1) \end{bmatrix} \begin{bmatrix} \bar{T}_1 \\ \bar{T}_2 \\ \bar{T}_3 \\ \bar{T}_4 \\ \bar{T}_5 \\ \bar{T}_6 \end{bmatrix}$$

$$= \begin{bmatrix} 4 \\ 20-2(4) \\ -15-1(4) \\ -3-5(4) \\ 16+3(4) \\ -27-4(4) \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 2 & -1 & -2 & -1 & 2 \\ 0 & -3 & 9 & -6 & -13 & 6 \\ 0 & 2 & -4 & 6 & 10 & 0 \\ 0 & -1 & 9 & 10 & -15 & 2 \end{bmatrix} \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -19 \\ -23 \\ 28 \\ -43 \end{bmatrix}$$

$$T_1 = -2/3$$

$$T_2 = -1$$

$$T_3 = -2/3$$

$$T_4 = 1/3$$

$$\begin{bmatrix} 1 & 2 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 2 + \frac{2}{3}(-3) & -1 + \frac{2}{3}(5) & -2 + \frac{2}{3}(0) & -1 + \frac{2}{3}(-5) & 2 + \frac{2}{3}(-1) \\ 0 & -3 - 1(-3) & 9 - 1(5) & -6 - 1(0) & -13 - 1(-5) & 6 - 1(-1) \\ 0 & 2 + \frac{2}{3}(-3) & 4 + \frac{2}{3}(5) & 6 + \frac{2}{3}(0) & 10 + \frac{2}{3}(-5) & 0 + \frac{2}{3}(-1) \\ 0 & -1 - \frac{1}{3}(-3) & 9 - \frac{1}{3}(5) & -16 - \frac{1}{3}(0) & -15 - \frac{1}{3}(-5) & 2 - \frac{1}{3}(-1) \end{bmatrix} \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -19 + \frac{2}{3}(12) \\ -23 - 1(12) \\ 28 + \frac{2}{3}(12) \\ -43 - \frac{1}{3}(12) \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & \frac{7}{3} & -2 & -\frac{13}{3} & \frac{4}{3} \\ 0 & 0 & 1 & -6 & -8 & 7 \\ 0 & 0 & -\frac{2}{3} & 6 & \frac{20}{3} & -\frac{2}{3} \\ 0 & 0 & \frac{22}{3} & -10 & -\frac{40}{3} & \frac{7}{3} \end{bmatrix} \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -35 \\ 36 \\ -47 \end{bmatrix}$$

$$\overline{T}_1 = 12/7$$

$$\overline{T}_2 = -2/4$$

$$\overline{T}_3 = 22/7$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 7/3 & -2 & -13/3 & 4/3 \\ 0 & 0 & 4 \cdot \frac{2}{7}(\frac{1}{3}) & -6 \cdot \frac{12}{7}(-2) & -8 \cdot \frac{12}{7}(-\frac{13}{3}) & 7 \cdot \frac{12}{7}(\frac{4}{3}) \\ 0 & 0 & -\frac{9}{3} \cdot \frac{2}{7}(\frac{1}{3}) & 6 + \frac{9}{7}(-2) & \frac{20}{3} + \frac{2}{7}(-\frac{13}{3}) & -\frac{2}{3} + \frac{2}{7}(\frac{4}{3}) \\ \sim 0 & 0 & \frac{22}{3} - \frac{22}{2}(\frac{7}{3}) & -10 \cdot \frac{22}{7}(-2) & -\frac{44}{3} - \frac{22}{7}(-\frac{13}{3}) & \frac{2}{3} - \frac{22}{7}(\frac{4}{3}) \end{bmatrix} \quad \begin{matrix} \overline{T}_1 \\ \overline{T}_2 \\ \overline{T}_3 \\ \overline{T}_4 \\ \overline{T}_5 \\ \overline{T}_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -35 \cdot \frac{12}{7}(11) \\ 3 + \frac{9}{7}(-10) \\ -1 + \frac{22}{7}(-11) \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 7/3 & -2 & -13/3 & 4/3 \\ 0 & 0 & 0 & -18/7 & -4/7 & 33/7 \\ 0 & 0 & 0 & 28/7 & 88/7 & -2/7 \\ 0 & 0 & 0 & -26/7 & 2/7 & -13/3 \end{bmatrix} \quad \begin{matrix} \overline{T}_1 \\ \overline{T}_2 \\ \overline{T}_3 \\ \overline{T}_4 \\ \overline{T}_5 \\ \overline{T}_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -113/7 \\ 230/7 \\ -82/7 \end{bmatrix}$$

$$\overline{T}_1 = -19/9, \overline{T}_2 = 13/9$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 7/3 & -2 & -13/3 & 4/3 \\ 0 & 0 & 0 & -18/7 & -4/7 & 33/7 \\ 0 & 0 & 0 & \frac{28}{7} + \frac{19}{7}(-\frac{18}{7}) & \frac{33}{7} + \frac{19}{7}(-\frac{4}{7}) & -\frac{2}{7} + \frac{19}{7}(\frac{33}{7}) \\ 0 & 0 & 0 & -\frac{26}{7} - \frac{13}{7}(-\frac{18}{7}) & \frac{2}{7} - \frac{13}{7}(-\frac{4}{7}) & -\frac{19}{7} - \frac{13}{7}(\frac{33}{7}) \end{bmatrix} \quad \begin{matrix} \overline{T}_1 \\ \overline{T}_2 \\ \overline{T}_3 \\ \overline{T}_4 \\ \overline{T}_5 \\ \overline{T}_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -113/7 \\ \frac{30+19}{7} \\ -\frac{189}{7} - \frac{13}{7} \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 7/3 & -2 & -13/3 & 4/3 \\ 0 & 0 & 0 & -18/7 & -4/7 & 33/7 \\ 0 & 0 & 0 & 0 & 38/9 & 29/3 \\ \sim 0 & 0 & 0 & 0 & 10/9 & 26/3 \end{bmatrix} \quad \begin{matrix} \overline{T}_1 \\ \overline{T}_2 \\ \overline{T}_3 \\ \overline{T}_4 \\ \overline{T}_5 \\ \overline{T}_6 \end{matrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -113/7 \\ -11/9 \\ 98/9 \end{bmatrix}$$

$$T_1 = 5/9$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 7/3 & -2 & -13/3 & 4/3 \\ 0 & 0 & 0 & -4/7 & -4/7 & 33/7 \\ 0 & 0 & 0 & 0 & 28/9 & 29/3 \\ 0 & 0 & 0 & 0 & 10/9 - 5/9(28/9) & -26/3 - 5/9(29/3) \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{bmatrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -113/7 \\ -11/9 \\ 98/9 - 5/9(-11/7) \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 7/3 & -2 & -13/3 & 4/3 \\ 0 & 0 & 0 & -18/7 & -4/7 & 33/7 \\ 0 & 0 & 0 & 0 & 28/9 & 29/3 \\ 0 & 0 & 0 & 0 & 0 & -213/19 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{bmatrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -113/7 \\ -11/9 \\ 213/19 \end{bmatrix}$$

$$-213/19 T_6 = 213/19$$

$$T_6 = 213/19 \times -19/213 = -1$$

$$28/9 T_5 + 29/3 T_6 = -11/9$$

$$T_5 = (-11/9 + 29/3) \times 9/28$$

$$T_4 = (-113/7 + 8/7 + 33/7) \times -7/18 = 4$$

$$T_3 = (-11 + 8 + 26/3 + 4/3) \times 3/7$$

$$T_2 = \frac{12 - 15 + 10 - 1}{-3} = -2$$

$$T_1 = 1 + 2 + 6 - 4 - 6 - 1 = 1$$

$$\therefore T_1 = 1, T_2 = -2, T_3 = 3, T_4 = 4, T_5 = 2, T_6 = 1$$