$$\frac{d^2y}{dx^2} = \frac{S}{EI}\, y + \frac{q}{2EI}\, x(x-l) \qquad y(0)=0,\quad y(l)=0$$

Using central differencing and applying boundary conditions to 1st and last: we can re-express $\frac{d^2y}{dx^2}$ as a derivative matrix:

$$\frac{d^2y}{dx^2} = \begin{pmatrix} f''_0 \\ f''_1 \\ f''_2 \\ \vdots \\ f''_{n-3} \\ f''_{n-2} \\ f''_{n-1} \end{pmatrix} = \frac{1}{\Delta^2}\begin{pmatrix} y_0 & -2y_1 & y_2 & 0 & \cdots & & & 0 \\ y_0 & -2y_1 & y_2 & 0 & & & & \vdots \\ 0 & y_1 & -2y_2 & y_3 & 0 & & & \\ \vdots & & \ddots & & & & & \\ 0 & \cdots & 0 & y_{n-4} & -2y_{n-3} & y_{n-2} & 0 \\ 0 & & \cdots & 0 & y_{n-3} & -2y_{n-2} & y_{n-1} \\ 0 & 0 & \cdots & & y_{n-3} & -2y_{n-2} & y_{n-1} \end{pmatrix} = \frac{1}{\Delta^2}\begin{pmatrix} 1 & -2 & 1 & 0 & \cdots & 0 \\ 1 & -2 & 1 & 0 & & \vdots \\ 0 & 1 & -2 & 1 & & \\ \vdots & & & \ddots & & \\ 0 & \cdots & 1 & -2 & 1 & 0 \\ 0 & \cdots & 0 & 1 & -2 & 1 \\ 0 & 0 & \cdots & 1 & -2 & 1 \end{pmatrix}\begin{pmatrix} y_0 \\ y_1 \\ y_2 \\ \vdots \\ y_{n-3} \\ y_{n-2} \\ y_{n-1} \end{pmatrix}$$

grouping the y terms on the LHS and solution (x) terms on RHS:

$$\left[\frac{1}{\Delta^2}\begin{pmatrix} 1 & -2 & 1 & \cdots & & 0 \\ 1 & -2 & 1 & 0 & \cdots & \vdots \\ 0 & 1 & -2 & 1 & 0 & \\ \vdots & & & \ddots & & \\ & & 1 & -2 & 1 & 0 \\ & & 0 & 1 & -2 & 1 \\ 0 & \cdots & & 1 & -2 & 1 \end{pmatrix} - \frac{S}{EI}\begin{pmatrix} 1 & 0 & 0 & \cdots & 0 \\ 0 & 1 & 0 & & \\ 0 & 0 & 1 & & \\ \vdots & & & \ddots & \\ 0 & \cdots & 1 & 0 & 0 \\ 0 & \cdots & 0 & 1 & 0 \\ 0 & \cdots & 0 & 0 & 1 \end{pmatrix}\right]\begin{pmatrix} y_0 \\ y_1 \\ y_2 \\ \vdots \\ y_{n-3} \\ y_{n-2} \\ y_{n-1} \end{pmatrix} = \frac{q}{2EI}\begin{pmatrix} x_1(x_1-l) \\ x_2(x_2-l) \\ \vdots \\ x_{n-2}(x_{n-2}-l) \\ x_{n-1}(x_{n-1}-l) \end{pmatrix}$$

$$\begin{pmatrix} \frac{1}{\Delta^2}-\frac{S}{EI} & \frac{-2}{\Delta^2} & \frac{1}{\Delta^2} & 0 & \cdots & 0 & 0 \\ \frac{1}{\Delta^2} & \frac{-2}{\Delta^2}-\frac{S}{EI} & \frac{1}{\Delta^2} & 0 & \cdots & & 0 \\ 0 & \frac{1}{\Delta^2} & \frac{-2}{\Delta^2}-\frac{S}{EI} & \frac{1}{\Delta^2} & & & \vdots \\ 0 & & & \ddots\ \frac{1}{\Delta^2} & \frac{-2}{\Delta^2}-\frac{S}{EI} & \frac{1}{\Delta^2} & 0 \\ 0 & & & 0 & \frac{1}{\Delta^2} & \frac{-2}{\Delta^2}-\frac{S}{EI} & \frac{1}{\Delta^2} \\ 0 & 0 & 0 \cdots & 0 & \frac{1}{\Delta^2} & \frac{-2}{\Delta^2} & \frac{1}{\Delta^2}-\frac{S}{EI} \end{pmatrix}\begin{pmatrix} y_0 \\ y_1 \\ y_2 \\ \vdots \\ y_{n-3} \\ y_{n-2} \\ y_{n-1} \end{pmatrix} = \frac{q}{2EI}\begin{pmatrix} x_1(x_1-l) \\ x_2(x_2-l) \\ x_3(x_3-l) \\ \vdots \\ x_{n-3}(x_{n-3}-l) \\ x_{n-2}(x_{n-2}-l) \\ x_{n-1}(x_{n-1}-l) \end{pmatrix}$$

To simplify, let $\alpha = \frac{1}{\Delta^2}$, $\beta = \frac{-2}{\Delta^2} - \frac{S}{EI}$, $\gamma = \frac{1}{\Delta^2}$, $Q_i = \frac{q}{2EI} x_i(x_i - l)$
and also replace 1st and last rows with B.C.'s $a=0,\ b=0$

$$\begin{pmatrix} 1 & 0 & 0 & \cdots & & 0 & 0 \\ \alpha & \beta & \gamma & 0 & \cdots & & 0 \\ 0 & \alpha & \beta & \gamma & & & \vdots \\ \vdots & & & \ddots\ \alpha & \beta & \gamma & 0 \\ 0 & & & & \alpha & \beta & \gamma \\ 0 & 0 & \cdots & & 0 & 0 & 1 \end{pmatrix}\begin{pmatrix} y_0 \\ y_1 \\ y_2 \\ \vdots \\ y_{n-3} \\ y_{n-2} \\ y_{n-1} \end{pmatrix} = \begin{pmatrix} a \\ Q_1 \\ Q_2 \\ \vdots \\ Q_{n-3} \\ Q_{n-2} \\ b \end{pmatrix}$$