# ANEXO_2_Segunda_combinación

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#### 0.0.1 Segunda combinación

$$U = 1.2 \cdot D + 1 \cdot EQ$$

**Ecuaciones de pendiente deflexión**

**Momentos de los extremos fijos (FEM)** Todas las vigas están sometidas a las cargas distribuidas con la misma configuracion, por lo tanto la distribucion de momentos en sus extremos fijos sería:

$$\mathrm{FEMy} = \frac{L^2 wy}{12}$$

La rotación de las columnas del primer y segundo piso debido a un desplazamiento lineal que genera la carga del viento se define como:

$$\psi_1 = -\frac{\Delta_1}{H}$$

$$\psi_2 = -\frac{\Delta_2}{H}$$

$$\mathrm{Fs}_1 = 720.000$$

$$\mathrm{Fs}_2 = 1440.000$$

**Momentos internos en los extremos de cada tramo** Los momentos en los extremos de cada tramo empotrado sería:

**Columnas primer piso**

$$M_{ab} = \frac{2EI\left(\frac{3\Delta_1}{H} + 2a + b\right)}{H}$$

$$M_{ba} = \frac{2EI\left(\frac{3\Delta_1}{H} + a + 2b\right)}{H}$$

$$M_{de} = \frac{2EI\left(\frac{3\Delta_1}{H} + 2d + e\right)}{H}$$

$$M_{ed} = \frac{2EI\left(\frac{3\Delta_1}{H} + d + 2e\right)}{H}$$

$$M_{gh} = \frac{2EI\left(\frac{3\Delta_1}{H} + 2g + h\right)}{H}$$

$$M_{hg} = \frac{2EI\left(\frac{3\Delta_1}{H} + g + 2h\right)}{H}$$

**Columnas segundo piso**

$$M_{bc} = \frac{2EI\left(\frac{3\Delta_2}{H} + 2b + c\right)}{H}$$

$$M_{cb} = \frac{2EI\left(\frac{3\Delta_2}{H} + b + 2c\right)}{H}$$

$$M_{ef} = \frac{2EI\left(\frac{3\Delta_2}{H} + 2e + f\right)}{H}$$

$$M_{fe} = \frac{2EI\left(\frac{3\Delta_2}{H} + e + 2f\right)}{H}$$

$$M_{hi} = \frac{2EI\left(\frac{3\Delta_2}{H} + 2h + i\right)}{H}$$

$$M_{ih} = \frac{2EI\left(\frac{3\Delta_2}{H} + h + 2i\right)}{H}$$

**Vigas del techo del segundo piso**

$$M_{cf} = \frac{2EI\,(2c+f)}{L} + \frac{L^2 wy}{12}$$

$$M_{fc} = \frac{2EI\,(c+2f)}{L} - \frac{L^2 wy}{12}$$

$$M_{fi} = \frac{2EI\,(2f+i)}{L} + \frac{L^2 wy}{12}$$

$$M_{if} = \frac{2EI\,(f+2i)}{L} - \frac{L^2 wy}{12}$$

**Vigas del techo del primer piso**

$$M_{be} = \frac{2EI\,(2b+e)}{L} + \frac{L^2 wy}{12}$$

$$M_{eb} = \frac{2EI\,(b+2e)}{L} - \frac{L^2 wy}{12}$$

$$M_{eh} = \frac{2EI\,(2e+h)}{L} + \frac{L^2 wy}{12}$$

$$M_{he} = \frac{2EI\,(e+2h)}{L} - \frac{L^2 wy}{12}$$

**Fórmula de cortantes**

**Cortantes del segundo piso**

$$\mathrm{Rbc} = \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+b+2c\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2b+c\right)}{H}}{H}$$

$$\mathrm{Ref} = \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+e+2f\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2e+f\right)}{H}}{H}$$

$$\mathrm{Rhi} = \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+h+2i\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2h+i\right)}{H}}{H}$$

**Cortantes del primer y segundo piso**

$$\mathrm{Rgh} = \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+g+2h\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2g+h\right)}{H}}{H}$$

$$\mathrm{Rde} = \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+d+2e\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2d+e\right)}{H}}{H}$$

$$\mathrm{Rab} = \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+a+2b\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2a+b\right)}{H}}{H}$$

**Ecuaciones de equilibrio**

**Equilibrio de momentos en los nodos C e I**

$$\begin{aligned}\text{eq}_C &= M_{cb} + M_{cf} \\ &= \frac{2EI\left(\frac{3\Delta_2}{H} + b + 2c\right)}{H} + \frac{2EI\,(2c+f)}{L} + \frac{L^2wy}{12} \\ &= \frac{2EI\,(2c+f)}{L} + \frac{2EI\left(\frac{3\Delta_2}{H} + b + 2c\right)}{H} + \frac{L^2wy}{12} \quad \text{(ecu.C)}\end{aligned}$$

$$\begin{aligned}\text{eq}_I &= M_{if} + M_{ih} \\ &= \frac{2EI\,(f+2i)}{L} - \frac{L^2wy}{12} + \frac{2EI\left(\frac{3\Delta_2}{H} + h + 2i\right)}{H} \\ &= \frac{2EI\,(f+2i)}{L} + \frac{2EI\left(\frac{3\Delta_2}{H} + h + 2i\right)}{H} - \frac{L^2wy}{12} \quad \text{(ecu.I)}\end{aligned}$$

**Equilibrio de momentos en los nodos B, H, F**

$$\begin{aligned}\text{eq}_F &= M_{fc} + M_{fi} + M_{fe} \\ &= \frac{2EI\,(c+2f)}{L} - \frac{L^2wy}{12} + \frac{2EI\,(2f+i)}{L} + \frac{L^2wy}{12} + \frac{2EI\left(\frac{3\Delta_2}{H} + e + 2f\right)}{H} \\ &= \frac{2EI\,(c+2f)}{L} + \frac{2EI\,(2f+i)}{L} + \frac{2EI\left(\frac{3\Delta_2}{H} + e + 2f\right)}{H} \quad \text{(ecu.F)}\end{aligned}$$

$$\begin{aligned}\text{eq}_B &= M_{ba} + M_{bc} + M_{be} \\ &= \frac{2EI\left(\frac{3\Delta_1}{H} + a + 2b\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H} + 2b + c\right)}{H} + \frac{2EI\,(2b+e)}{L} + \frac{L^2wy}{12} \\ &= \frac{2EI\,(2b+e)}{L} + \frac{2EI\left(\frac{3\Delta_1}{H} + a + 2b\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H} + 2b + c\right)}{H} + \frac{L^2wy}{12} \quad \text{(ecu.B)}\end{aligned}$$

$$\begin{aligned}\text{eq}_H &= M_{hg} + M_{he} + M_{hi} \\ &= \frac{2EI\left(\frac{3\Delta_1}{H} + g + 2h\right)}{H} + \frac{2EI\,(e+2h)}{L} - \frac{L^2wy}{12} + \frac{2EI\left(\frac{3\Delta_2}{H} + 2h + i\right)}{H} \\ &= \frac{2EI\,(e+2h)}{L} + \frac{2EI\left(\frac{3\Delta_1}{H} + g + 2h\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H} + 2h + i\right)}{H} - \frac{L^2wy}{12} \quad \text{(ecu.H)}\end{aligned}$$

Equilibrio de momentos en el nodo E

$$
\begin{aligned}
\mathrm{eq}_E &= M_{ed} + M_{eb} + M_{eh} + M_{ef} \\
&= \frac{2EI\left(\frac{3\Delta_1}{H} + d + 2e\right)}{H} + \frac{2EI\left(b + 2e\right)}{L} - \frac{L^2 wy}{12} + \frac{2EI\left(2e + h\right)}{L} + \frac{L^2 wy}{12} + \frac{2EI\left(\frac{3\Delta_2}{H} + 2e + f\right)}{H} \\
&= \frac{2EI\left(b + 2e\right)}{L} + \frac{2EI\left(2e + h\right)}{L} + \frac{2EI\left(\frac{3\Delta_1}{H} + d + 2e\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H} + 2e + f\right)}{H} \quad \text{(ecu.E)}
\end{aligned}
$$

**Equilibrio de fuerzas en el piso 1**

$$
\begin{aligned}
\mathrm{eq}_{V1} &= \mathrm{Fs}_1 + \mathrm{Fs}_2 - \left(\mathrm{Rgh} + \mathrm{Rde} + \mathrm{Rab}\right) \\
&= 720.000 + 1440.000 - \left( \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+g+2h\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2g+h\right)}{H}}{H} + \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+d+2e\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2d+e\right)}{H}}{H} + \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+a+2b\right.}{H}}{} \right. \\
&= 2160.0 - \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+a+2b\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2a+b\right)}{H}}{H} - \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+d+2e\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2d+e\right)}{H}}{H} - \frac{\frac{2EI\left(\frac{3\Delta_1}{H}+g+2h\right)}{H} + \frac{2EI\left(\frac{3\Delta_1}{H}+2g\right.}{H}}{H}
\end{aligned}
$$

**Equilibrio de fuerzas en el piso 2**

$$
\begin{aligned}
\mathrm{eq}_{V2} &= \mathrm{Fs}_2 - \left(\mathrm{Rbc} + \mathrm{Ref} + \mathrm{Rhi}\right) \\
&= 1440.000 - \left( \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+b+2c\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2b+c\right)}{H}}{H} + \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+e+2f\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2e+f\right)}{H}}{H} + \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+h+2i\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}\right.}{H}}{H} \right. \\
&= 1440.0 - \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+b+2c\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2b+c\right)}{H}}{H} - \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+e+2f\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2e+f\right)}{H}}{H} - \frac{\frac{2EI\left(\frac{3\Delta_2}{H}+h+2i\right)}{H} + \frac{2EI\left(\frac{3\Delta_2}{H}+2h\right.}{H}}{H}
\end{aligned}
$$

Reemplazando con los datos conocidos y asisgando a la inercia con el valor de $I = 1ft^4$:

$$E = 1 \ \ (kip/ft^2)$$

$$I = 1 \ \ (ft^4)$$

$$L = 16 \ \ (ft)$$

$$H = 12 \ \ (ft)$$

Considerando las combinaciones de carga

$$w_D = 150 \ \ (k/ft)$$

$$\mathrm{EQ} = 1440.000 \ \ (k)$$

$$\mathrm{wy} = 180.000 \ \ (k/ft)$$

Ademas, los giros en los extremos empotrados es cero

$$a = 0$$

$$d = 0$$

$$g = 0$$

Los momentos internos en los extremos de cada tramo serían:

```
720.0
1440.0
```

$$\psi_1 = -\frac{\Delta_1}{12}$$

$$\psi_2 = -\frac{\Delta_2}{12}$$

$$M_{ab} = 0.042\Delta_1 + 0.167b$$

$$M_{ba} = 0.042\Delta_1 + 0.333b$$

$$M_{de} = 0.042\Delta_1 + 0.167e$$

$$M_{ed} = 0.042\Delta_1 + 0.333e$$

$$M_{gh} = 0.042\Delta_1 + 0.167h$$

$$M_{hg} = 0.042\Delta_1 + 0.333h$$

$$M_{bc} = 0.042\Delta_2 + 0.333b + 0.167c$$

$$M_{cb} = 0.042\Delta_2 + 0.167b + 0.333c$$

$$M_{ef} = 0.042\Delta_2 + 0.333e + 0.167f$$

$$M_{fe} = 0.042\Delta_2 + 0.167e + 0.333f$$

$$M_{hi} = 0.042\Delta_2 + 0.333h + 0.167i$$

$$M_{ih} = 0.042\Delta_2 + 0.167h + 0.333i$$

$$M_{cf} = 0.25c + 0.125f + 3840.0$$

$$M_{fc} = 0.125c + 0.25f - 3840.0$$

$$M_{fi} = 0.25f + 0.125i + 3840.0$$

$$M_{if} = 0.125f + 0.25i - 3840.0$$

$$M_{be} = 0.25b + 0.125e + 3840.0$$

$$M_{eb} = 0.125b + 0.25e - 3840.0$$

$$M_{eh} = 0.25e + 0.125h + 3840.0$$

$$M_{he} = 0.125e + 0.25h - 3840.0$$

Las cortantes internas en las bastes de cada columna serían:

Las ecuacioens de equilibrio serían:

$$
\begin{aligned}
\mathrm{eq}_B &= M_{ba} + M_{bc} + M_{be} \\
&= 0.042\Delta_1 + 0.333b + 0.042\Delta_2 + 0.333b + 0.167c + 0.25b + 0.125e + 3840.0 \\
&= 0.042\Delta_1 + 0.042\Delta_2 + 0.917b + 0.167c + 0.125e + 3840.0 \quad \text{(e1)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_C &= M_{cb} + M_{cf} \\
&= 0.042\Delta_2 + 0.167b + 0.333c + 0.25c + 0.125f + 3840.0 \\
&= 0.042\Delta_2 + 0.167b + 0.583c + 0.125f + 3840.0 \quad \text{(e2)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_E &= M_{ed} + M_{eb} + M_{eh} + M_{ef} \\
&= 0.042\Delta_1 + 0.333e + 0.125b + 0.25e - 3840.0 + 0.25e + 0.125h + 3840.0 + 0.042\Delta_2 + 0.333e + 0.167f \\
&= 0.042\Delta_1 + 0.042\Delta_2 + 0.125b + 1.167e + 0.167f + 0.125h \quad \text{(e3)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_F &= M_{fc} + M_{fi} + M_{fe} \\
&= 0.125c + 0.25f - 3840.0 + 0.25f + 0.125i + 3840.0 + 0.042\Delta_2 + 0.167e + 0.333f \\
&= 0.042\Delta_2 + 0.125c + 0.167e + 0.833f + 0.125i \quad \text{(e4)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_H &= M_{hg} + M_{he} + M_{hi} \\
&= 0.042\Delta_1 + 0.333h + 0.125e + 0.25h - 3840.0 + 0.042\Delta_2 + 0.333h + 0.167i \\
&= 0.042\Delta_1 + 0.042\Delta_2 + 0.125e + 0.917h + 0.167i - 3840.0 \quad \text{(e5)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_I &= M_{if} + M_{ih} \\
&= 0.125f + 0.25i - 3840.0 + 0.042\Delta_2 + 0.167h + 0.333i \\
&= 0.042\Delta_2 + 0.125f + 0.167h + 0.583i - 3840.0 \quad \text{(e6)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_{V1} &= \mathrm{Fs}_1 + \mathrm{Fs}_2 - (\mathrm{Rgh} + \mathrm{Rde} + \mathrm{Rab}) \\
&= 720.000 + 1440.000 - (0.007\Delta_1 + 0.042h + 0.007\Delta_1 + 0.042e + 0.007\Delta_1 + 0.042b) \\
&= -0.021\Delta_1 - 0.042b - 0.042e - 0.042h + 2160.0 \quad \text{(e7)}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{eq}_{V2} &= \mathrm{Fs}_2 - (\mathrm{Rbc} + \mathrm{Ref} + \mathrm{Rhi}) \\
&= 1440.000 - (0.007\Delta_2 + 0.042b + 0.042c + 0.007\Delta_2 + 0.042e + 0.042f + 0.007\Delta_2 + 0.042h + 0.042i) \\
&= -0.021\Delta_2 - 0.042b - 0.042c - 0.042e - 0.042f - 0.042h - 0.042i + 1440.0 \quad \text{(e8)}
\end{aligned}
$$

### 0.0.2 Solución del sistema de ecuaciones

Se tiene 8 varaibles y 8 ecuaciones, la solución del sistema de ecuaciones es:

```
b= -16868.7940  rad,            c= -13962.2220  rad,           e= -9311.8673
rad
b= -4932.4740  rad,            c= -10556.4653  rad,           e= -2600.0302  rad
Desplazamiento piso 1= 177154.2533  ft,           Desplazamiento piso 2=
185583.7055  ft
El desplazamiento total:  362737.9588  ft
```

**¿CUMPLE EL CRITERIO DE DESPLAZAMIENTO MÁXIMO?**

$$\Delta_{max} = \frac{H}{400} = \frac{12}{400} \;= 0.03 \; ft$$

Los desplazamientos obtenidos asisgando a la inercia con el valor de $I = 1ft^4$ son

$$\mathrm{dx}_1 = 177154.253 \;\; \mathrm{(ft)}$$

$$\mathrm{dx}_2 = 185583.706 \;\; \mathrm{(ft)}$$

Por lo tanto, pada cumplir con el desplazamiento máximo permitido, la inercia mínimo debería ser:

$$E = 4176000 \;\; (kip/ft^2)$$

$$I_{min} = 2.895 \;\; (ft^4 \text{ absoluto})$$

Sin embargo por un factor de seguridad decimios trabajar con un valor de inercia:

$$I = 3 \;\; (ft^4)$$

Realizando el mismo procedimiento anterior, obtenemos las siguientes soluciones:

Sistema de acuaciones con el momento de inercia ya ajustado

$$\begin{aligned}
\mathrm{eq}_B &= M_{ba} + M_{bc} + M_{be}\\
&= 522000.0\Delta_1 + 4176000.0b + 522000.0\Delta_2 + 4176000.0b + 2088000.0c + 3132000.0b + 1566000.0e + 3840.0\\
&= 522000.0\Delta_1 + 522000.0\Delta_2 + 11484000.0b + 2088000.0c + 1566000.0e + 3840.0 \ \ \text{(e1)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_C &= M_{cb} + M_{cf}\\
&= 522000.0\Delta_2 + 2088000.0b + 4176000.0c + 3132000.0c + 1566000.0f + 3840.0\\
&= 522000.0\Delta_2 + 2088000.0b + 7308000.0c + 1566000.0f + 3840.0 \ \ \text{(e2)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_E &= M_{ed} + M_{eb} + M_{eh} + M_{ef}\\
&= 522000.0\Delta_1 + 4176000.0e + 1566000.0b + 3132000.0e - 3840.0 + 3132000.0e + 1566000.0h + 3840.0 + 5220\\
&= 522000.0\Delta_1 + 522000.0\Delta_2 + 1566000.0b + 14616000.0e + 2088000.0f + 1566000.0h \ \ \text{(e3)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_F &= M_{fc} + M_{fi} + M_{fe}\\
&= 1566000.0c + 3132000.0f - 3840.0 + 3132000.0f + 1566000.0i + 3840.0 + 522000.0\Delta_2 + 2088000.0e + 4176\\
&= 522000.0\Delta_2 + 1566000.0c + 2088000.0e + 10440000.0f + 1566000.0i \ \ \text{(e4)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_H &= M_{hg} + M_{he} + M_{hi}\\
&= 522000.0\Delta_1 + 4176000.0h + 1566000.0e + 3132000.0h - 3840.0 + 522000.0\Delta_2 + 4176000.0h + 2088000.0i\\
&= 522000.0\Delta_1 + 522000.0\Delta_2 + 1566000.0e + 11484000.0h + 2088000.0i - 3840.0 \ \ \text{(e5)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_I &= M_{if} + M_{ih}\\
&= 1566000.0f + 3132000.0i - 3840.0 + 522000.0\Delta_2 + 2088000.0h + 4176000.0i\\
&= 522000.0\Delta_2 + 1566000.0f + 2088000.0h + 7308000.0i - 3840.0 \ \ \text{(e6)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_{V1} &= \mathrm{Fs}_1 + \mathrm{Fs}_2 - (\mathrm{Rgh} + \mathrm{Rde} + \mathrm{Rab})\\
&= 720.000 + 1440.000 - (87000.0\Delta_1 + 522000.0h + 87000.0\Delta_1 + 522000.0e + 87000.0\Delta_1 + 522000.0b)\\
&= -261000.0\Delta_1 - 522000.0b - 522000.0e - 522000.0h + 2160.0 \ \ \text{(e7)}
\end{aligned}$$

$$\begin{aligned}
\mathrm{eq}_{V2} &= \mathrm{Fs}_2 - (\mathrm{Rbc} + \mathrm{Ref} + \mathrm{Rhi})\\
&= 1440.000 - (87000.0\Delta_2 + 522000.0b + 522000.0c + 87000.0\Delta_2 + 522000.0e + 522000.0f + 87000.0\Delta_2 + 522\\
&= -261000.0\Delta_2 - 522000.0b - 522000.0c - 522000.0e - 522000.0f - 522000.0h - 522000.0i + 1440.0 \ \ \text{(e8)}
\end{aligned}$$

Solución del sistema de ecuaciones

$R2 = Delta1 : 0.0141406651733419, Delta2 : 0.0148135141711170, b : -0.00134648739209896, c : -0.00111448131818$

**Solución de los momentos y las costantes de cada tramo**

[192]:

| | Tramos | Momentos k ft | Cortantes kip |
|---|---|---|---|
| 0 | AB | 4569.96 | 527.37 |
| 1 | BA | 1758.50 | -527.37 |
| 2 | BC | -217.31 | 4.15 |
| 3 | CB | 267.11 | -4.15 |
| 4 | DE | 5829.45 | 842.24 |
| 5 | ED | 4277.47 | -842.24 |
| 6 | EF | 3806.62 | 695.26 |
| 7 | FE | 4536.52 | -695.26 |
| 8 | GH | 5622.02 | 790.39 |
| 9 | HG | 3862.61 | -790.39 |
| 10 | HI | 3780.49 | 740.59 |
| 11 | IH | 5106.57 | -740.59 |
| 12 | BE | -1541.18 | 826.39 |
| 13 | EB | -8276.57 | 2053.61 |
| 14 | CF | -267.11 | 997.16 |
| 15 | FC | -6818.40 | 1882.84 |
| 16 | EH | 192.48 | 974.34 |
| 17 | HE | -7643.10 | 1905.66 |
| 18 | FI | 2281.88 | 1263.46 |
| 19 | IF | -5106.57 | 1616.54 |

**Reacciones del sistema**

$$M_A = 4569.962 \ \ (kip \cdot ft)$$

$$M_D = 5829.449 \ \ (kip \cdot ft)$$

$$M_G = 5622.016 \ \ (kip \cdot ft)$$

$$R_{Ay} = 1823.546 \ \ (kip)$$

$$R_{Dy} = 6174.247 \ \ (kip)$$

$$R_{Gy} = 3522.207 \ \ (kip)$$

$$R_{Ax} = -527.371 \ \ (kip)$$

$$R_{Dx} = -842.243 \ \ (kip)$$

$$R_{Gx} = -790.385 \ \ (kip)$$

$$\Delta_1 = 0.014 \ \ (ft)$$

$$\Delta_2 = 0.015 \ \ (ft)$$

## ¿CUMPLE EL CRITERIO DE DESPLAZAMIENTO MÁXIMO?

$$\Delta_{max} = \frac{H}{400} = \frac{12}{400} \ = 0.03 \ ft$$

```
El desplazamiento del primer piso relativo es:  0.0141  ft
El desplazamiento del segundo piso relativo es:  0.0148  ft
El desplazamiento del segundo piso absoluto es:  0.0289  ft
Empleando una sección con inercia I= 3  ft^4, los desplazamientos son menores al
máximo permitido
```

**Propiedades finales que cumplen con ambas combinaciones son:**

$$E = 4176000 \ \ (kip/ft^2)$$

$$I_{final} = 3 \ \ (ft^4)$$