

Actividad 2:

b) Calcular la deflexión máxima, aplicando la ecuación elástica.

$$M(x) = -353.31x + 680 \langle x-12 \rangle - 507.47 \langle x-33 \rangle$$

Sabemos que:

$$EI \frac{d^2 y}{dx^2} = M(x)$$

Por lo tanto:

$$EI \frac{dy}{dx} = \int M(x) dx$$

$$EI \frac{dy}{dx} = -353.31 \frac{x^2}{2} + 680 \frac{\langle x-12 \rangle^2}{2}$$

$$- 507.47 \frac{\langle x-33 \rangle^2}{2} + C_1$$

$$\therefore EI y(x) = -353.31 \frac{x^3}{6} + 680 \frac{\langle x-12 \rangle^3}{6} - 507.47 \frac{\langle x-33 \rangle^3}{6} + C_1 x + C_2$$

Conocemos:

$$E = 29.007 \text{ Mpsi}$$

$$\therefore EI = 12.814 \times 10^6$$

$$I = \frac{\pi r^4}{4} = \frac{\pi (0.75)^4}{4} = 0.4417$$

$$\delta(x) = \frac{1}{12.814 \times 10^6} \left[-353.31 \frac{x^3}{6} + 680 \frac{\langle x-12 \rangle^3}{6} - 507.47 \frac{\langle x-33 \rangle^3}{6} + C_1 x + C_2 \right]$$

Aplicando condiciones de frontera

$$\delta(0) = 0$$

$$\therefore C_1 = 31387$$

$$\delta(48) = 0$$

$$C_2 = 0$$

La funcion original

$$z(x) = \frac{1}{12.814 \times 10^6} \left(-353.31 \left(\frac{x^3}{6} \right) + 680 \left(\frac{(x-12)^3}{6} \right) - 501.42 \left(\frac{(x-33)^3}{6} \right) + 31387x \right)$$

Segmento 1

$$0 < x < 12$$

$$z(x) = \frac{1}{12.814 \times 10^6} \left(-353.31 \left(\frac{x^3}{6} \right) + 31387x \right)$$

$$\frac{d(z(x))}{dx} = 0, \text{ Solution is: } 13.329$$

$$z(13.329) = 2.1766 \times 10^{-2}$$

Segmento 2

$$12 < x < 33$$

$$z(x) = \frac{1}{12.814 \times 10^6} \left(-353.31 \left(\frac{x^3}{6} \right) + 680 \left(\frac{(x-12)^3}{6} \right) + 31387x \right)$$

$$\frac{d(z(x))}{dx} = 0, \text{ Solution is: } 13.488$$

$$z(13.488) = 2.1791 \times 10^{-2}$$

Segmento 3

$$33 < x < 48$$

$$z(x) = \frac{1}{12.814 \times 10^6} \left(-353.31 \left(\frac{x^3}{6} \right) + 680 \left(\frac{(x-12)^3}{6} \right) - 501.42 \left(\frac{(x-33)^3}{6} \right) + 31387x \right)$$

$$\frac{d(z(x))}{dx} = 0, \text{ Solution is: } 38.075$$

$$z(38.075) = -4.4433 \times 10^{-3}$$

Por lo tanto el valor maximo, es el valor maximo de los valores maximos de los 3 segmentos

$$z_{\max}(x) = 2.1791 \times 10^{-2}$$

Dado que se trata de una función segmentada, consideré que obtener el valor máximo de toda la función de forma completa no sería lo más adecuado. Al hacerlo inicialmente, obtuve un resultado muy alejado de lo esperado. Por esta razón, opté por calcular los valores máximos por separado en cada segmento, lo cual me permitió obtener resultados más coherentes y cercanos a los valores obtenidos en ANSYS.

VALOR OBTENIDO EN ANSYS

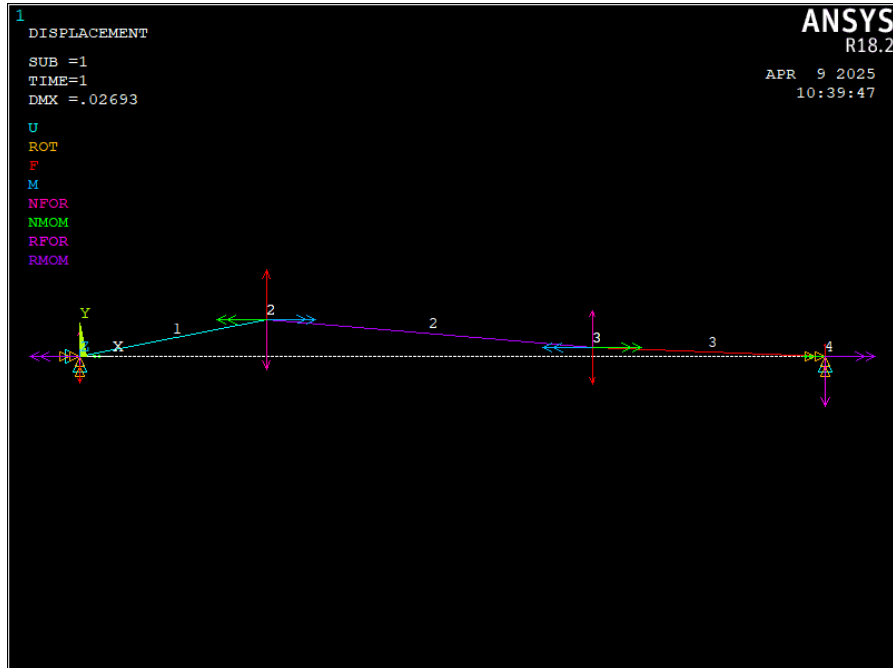
PRINT U NODAL SOLUTION PER NODE

NODE	UX	UY	UZ	USUM
1	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.26930E-001	0.0000	0.26930E-001
3	0.0000	0.68446E-002	0.0000	0.68446E-002
4	0.0000	0.0000	0.0000	0.0000

MAXIMUM ABSOLUTE VALUES

NODE	0	2	0	2
VALUE	0.0000	0.26930E-001	0.0000	0.26930E-001

c) ¿ El eje soporta las cargas? Respaldar respuesta en base a la teoría de falla empleada y especificaciones de material, citar la referencia y mandar impresión de pantalla.



Deformación visual obtenida en ANSYS

Esfuerzo de Von Mises obtenido en ANSYS

PRINT S PRIN ELEMENT SOLUTION PER ELEMENT

STRESSES AT BEAM SECTION NODAL POINTS

ELEMENT = 1 SECTION ID = 1

ELEMENT NODE = 1

SEC NODE	S1	S2	S3	SINT	SEQV
1	0.71687E-013	0.71624E-024	-0.12853E-012	0.20022E-012	0.17571E-012
3	4783.8	-0.38440E-007	-250.48	5034.3	4913.9
9	3543.7	0.40187E-008	-338.13	3881.8	3724.3
11	3543.7	0.40186E-008	-338.13	3881.8	3724.3
17	1094.6	0.0000	-1094.6	2189.3	1896.0
19	1094.6	0.0000	-1094.6	2189.3	1896.0
25	338.13	0.33513E-007	-3543.7	3881.8	3724.3
27	338.13	0.33513E-007	-3543.7	3881.8	3724.3
33	250.48	0.87112E-007	-4783.8	5034.3	4913.9
35	6765.4	-0.54363E-007	-354.23	7119.6	6949.2
41	5011.5	0.56836E-008	-478.19	5489.7	5266.9
43	5011.5	0.56831E-008	-478.19	5489.7	5266.9
49	1548.1	0.0000	-1548.1	3096.1	2681.3
51	1548.1	0.0000	-1548.1	3096.1	2681.3
57	478.19	0.47394E-007	-5011.5	5489.7	5266.9
59	478.19	0.47394E-007	-5011.5	5489.7	5266.9
65	354.23	0.12320E-006	-6765.4	7119.6	6949.2
Max=	6765.4	0.12320E-006	-0.12853E-012	7119.6	6949.2
Min=	0.71687E-013	-0.54363E-007	-6765.4	0.20022E-012	0.17571E-012

ELEMENT NODE = 2

SEC NODE	S1	S2	S3	SINT	SEQV
1	0.71687E-013	0.71624E-024	-0.12853E-012	0.20022E-012	0.17571E-012
3	4783.8	-0.38440E-007	-250.48	5034.3	4913.9
9	3543.7	0.40187E-008	-338.13	3881.8	3724.3
11	3543.7	0.40186E-008	-338.13	3881.8	3724.3
17	1094.6	0.0000	-1094.6	2189.3	1896.0
19	1094.6	0.0000	-1094.6	2189.3	1896.0
25	338.13	0.33513E-007	-3543.7	3881.8	3724.3
27	338.13	0.33513E-007	-3543.7	3881.8	3724.3
33	250.48	0.87112E-007	-4783.8	5034.3	4913.9
35	6765.4	-0.54363E-007	-354.23	7119.6	6949.2
41	5011.5	0.56836E-008	-478.19	5489.7	5266.9
43	5011.5	0.56831E-008	-478.19	5489.7	5266.9
49	1548.1	0.0000	-1548.1	3096.1	2681.3
51	1548.1	0.0000	-1548.1	3096.1	2681.3
57	478.19	0.47394E-007	-5011.5	5489.7	5266.9
59	478.19	0.47394E-007	-5011.5	5489.7	5266.9
65	354.23	0.12320E-006	-6765.4	7119.6	6949.2
Max=	6765.4	0.12320E-006	-0.12853E-012	7119.6	6949.2
Min=	0.71687E-013	-0.54363E-007	-6765.4	0.20022E-012	0.17571E-012

STRESSES AT BEAM SECTION NODAL POINTS

ELEMENT = 2 SECTION ID = 1

ELEMENT NODE = 2

SEC NODE	S1	S2	S3	SINT	SEQV
1	0.18376E-013	0.13680E-023	-0.16759E-012	0.18597E-012	0.17749E-012
3	2517.9	0.21362E-007	-786.69	3304.6	2989.9

9	2146.8	0.19691E-007	-922.67	3069.5	2727.8
11	2146.8	0.19691E-007	-922.67	3069.5	2727.8
17	1407.4	0.0000	-1407.4	2814.8	2437.7
19	1407.4	0.0000	-1407.4	2814.8	2437.7
25	922.67	0.99859E-008	-2146.8	3069.5	2727.8
27	922.67	0.99859E-008	-2146.8	3069.5	2727.8
33	786.69	0.10587E-007	-2517.9	3304.6	2989.9
35	3560.8	0.30211E-007	-1112.5	4673.3	4228.3
41	3036.0	0.27847E-007	-1304.8	4340.9	3857.7
43	3036.0	0.27847E-007	-1304.8	4340.9	3857.7
49	1990.4	0.0000	-1990.4	3980.7	3447.4
51	1990.4	0.0000	-1990.4	3980.7	3447.4
57	1304.8	0.14122E-007	-3036.0	4340.9	3857.7
59	1304.8	0.14122E-007	-3036.0	4340.9	3857.7
65	1112.5	0.14973E-007	-3560.8	4673.3	4228.3

Max= 3560.8 0.30211E-007 -0.16759E-012 4673.3 4228.3

Min= 0.18376E-013 0.0000 -3560.8 0.18597E-012 0.17749E-012

ELEMENT NODE = 3

SEC NODE	S1	S2	S3	SINT	SEQV
1	0.18376E-013	0.13680E-023	-0.16759E-012	0.18597E-012	0.17749E-012
3	2517.9	0.21362E-007	-786.69	3304.6	2989.9
9	2146.8	0.19691E-007	-922.67	3069.5	2727.8
11	2146.8	0.19691E-007	-922.67	3069.5	2727.8
17	1407.4	0.0000	-1407.4	2814.8	2437.7
19	1407.4	0.0000	-1407.4	2814.8	2437.7
25	922.67	0.99859E-008	-2146.8	3069.5	2727.8
27	922.67	0.99859E-008	-2146.8	3069.5	2727.8
33	786.69	0.10587E-007	-2517.9	3304.6	2989.9
35	3560.8	0.30211E-007	-1112.5	4673.3	4228.3
41	3036.0	0.27847E-007	-1304.8	4340.9	3857.7
43	3036.0	0.27847E-007	-1304.8	4340.9	3857.7
49	1990.4	0.0000	-1990.4	3980.7	3447.4
51	1990.4	0.0000	-1990.4	3980.7	3447.4
57	1304.8	0.14122E-007	-3036.0	4340.9	3857.7
59	1304.8	0.14122E-007	-3036.0	4340.9	3857.7
65	1112.5	0.14973E-007	-3560.8	4673.3	4228.3

Max= 3560.8 0.30211E-007 -0.16759E-012 4673.3 4228.3

Min= 0.18376E-013 0.0000 -3560.8 0.18597E-012 0.17749E-012

STRESSES AT BEAM SECTION NODAL POINTS

ELEMENT = 3 SECTION ID = 1

ELEMENT NODE = 3

SEC NODE	S1	S2	S3	SINT	SEQV
1	0.15785E-012	0.14039E-023	-0.58372E-013	0.21622E-012	0.19375E-012
3	376.92	0.23944E-007	-3179.1	3556.0	3383.3
9	485.69	0.11974E-007	-2467.1	2952.8	2742.4
11	485.69	0.11974E-007	-2467.1	2952.8	2742.4
17	1094.6	0.0000	-1094.6	2189.3	1896.0
19	1094.6	0.0000	-1094.6	2189.3	1896.0
25	2467.1	0.16575E-007	-485.69	2952.8	2742.4
27	2467.1	0.16575E-007	-485.69	2952.8	2742.4
33	3179.1	0.10437E-007	-376.92	3556.0	3383.3
35	533.04	0.33862E-007	-4495.9	5028.9	4784.7
41	686.86	0.16933E-007	-3489.0	4175.9	3878.4
43	686.86	0.16933E-007	-3489.0	4175.9	3878.4
49	1548.1	0.0000	-1548.1	3096.1	2681.3
51	1548.1	0.0000	-1548.1	3096.1	2681.3

57	3489.0	0.23441E-007	-686.86	4175.9	3878.4
59	3489.0	0.23441E-007	-686.86	4175.9	3878.4
65	4495.9	0.14760E-007	-533.04	5028.9	4784.7

Max= 4495.9 0.33862E-007 -0.58372E-013 5028.9 4784.7

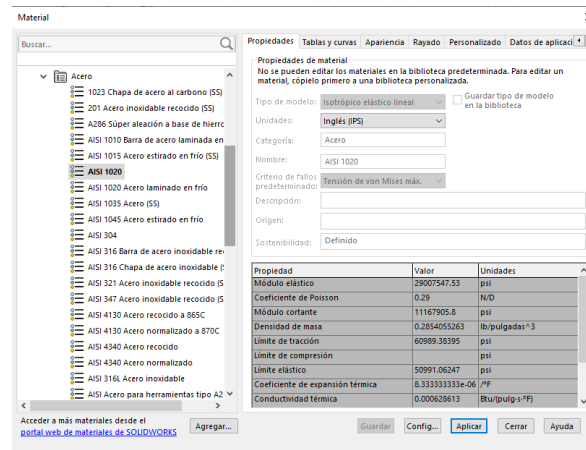
Min= 0.15785E-012 0.0000 -4495.9 0.21622E-012 0.19375E-012

ELEMENT NODE = 4

SEC	NODE	S1	S2	S3	SINT	SEQV
1		0.15785E-012	0.14039E-023	-0.58372E-013	0.21622E-012	0.19375E-012
3		376.92	0.23944E-007	-3179.1	3556.0	3383.3
9		485.69	0.11974E-007	-2467.1	2952.8	2742.4
11		485.69	0.11974E-007	-2467.1	2952.8	2742.4
17		1094.6	0.0000	-1094.6	2189.3	1896.0
19		1094.6	0.0000	-1094.6	2189.3	1896.0
25		2467.1	0.16575E-007	-485.69	2952.8	2742.4
27		2467.1	0.16575E-007	-485.69	2952.8	2742.4
33		3179.1	0.10437E-007	-376.92	3556.0	3383.3
35		533.04	0.33862E-007	-4495.9	5028.9	4784.7
41		686.86	0.16933E-007	-3489.0	4175.9	3878.4
43		686.86	0.16933E-007	-3489.0	4175.9	3878.4
49		1548.1	0.0000	-1548.1	3096.1	2681.3
51		1548.1	0.0000	-1548.1	3096.1	2681.3
57		3489.0	0.23441E-007	-686.86	4175.9	3878.4
59		3489.0	0.23441E-007	-686.86	4175.9	3878.4
65		4495.9	0.14760E-007	-533.04	5028.9	4784.7

Max= 4495.9 0.33862E-007 -0.58372E-013 5028.9 4784.7

Min= 0.15785E-012 0.0000 -4495.9 0.21622E-012 0.19375E-012



Dado que el esfuerzo de cedencia del material seleccionado, AISI 1020, es considerablemente superior al esfuerzo máximo que se ejerce sobre el eje, se puede concluir que dicho esfuerzo solo genera deformaciones dentro de la región elástica del material. Por lo tanto, el eje podrá soportar las cargas aplicadas con un buen factor de seguridad.