PROKON Support Portal

Unexpected result: the heavier section fails, while the lighter section passes.

Johan - 2019-08-22 - 0 Comments - in S01:Member design for axial stress

When a member fails the design checks, the easiest solution is to select and assign a heavier section to that member. This is true in most cases.

However, there are some peculiar cases where this is not true. The best way to illustrate this phenomenon is by using an example.

The members considered in the example are diagonal members in a truss which are all subjected to tensile forces.

Note that the 50 x 50 x 4 L does not meet the L/r requirements:

Design parameters		
Kv factor		0.85
Kx factor		0.85
Ky factor		1.00
Kz factor		1.00
Ane/Ag		1.00
Fy	MPa	300.00
Fu	MPa	450.00

Maximum L/r ratios		
L Case	Compr.	Tension
C1	200	300
C2	200	300
C3	200	300

Element	Length (m)	L.C.	Force (kN)	L/R	Crit Axis	Section	Pc (MPa)	σc (MPa)	Result
GROUP 5	Angles (Equal leg)								
4-5	3.487	C2	-6.14	303	V	50x50x4	270.0	15.8	Fail
6-7	3.488	C2	-3.72	303	V	50x50x4	270.0	9.6	Fail
8-9	3.488	C2	-1.13	303	V	50x50x4	270.0	2.9	Fail
18-19	3.487	C2	-6.29	303	V	50x50x4	270.0	16.2	Fail
20-21	3.488	C2	-3.91	303	V	50x50x4	270.0	10.1	Fail
22-23	3.488	C2	-1.32	303	V	50x50x4	270.0	3.4	Fail
32-33	3.487	C2	-6.48	303	V	50x50x4	270.0	16.7	Fail
34-35	3.488	C2	-4.10	303	V	50x50x4	270.0	10.5	Fail
36-37	3.488	C2	-1.52	303	V	50x50x4	270.0	3.9	Fail
9-12	3.488	C2	-1.51	303	V	50x50x4	270.0	3.9	Fail
11-14	3.488	C2	-4.09	303	V	50x50x4	270.0	10.5	Fail
13-18	3.488	C2	-6.48	303	V	50x50x4	270.0	16.7	Fail
23-26	3.488	C2	-1.31	303	V	50x50x4	270.0	3.4	Fail
25-28	3.488	C2	-3.90	303	V	50x50x4	270.0	10.0	Fail
27-32	3.488	C2	-6.29	303	V	50x50x4	270.0	16.2	Fail
37-40	3.488	C2	-1.12	303	V	50x50x4	270.0	2.9	Fail
39-42	3.488	C2	-3.71	303	V	50x50x4	270.0	9.5	Fail
41-46	3.488	C2	-6.14	303	V	50x50x4	270.0	15.8	Fail

The 50 x 50 x 3 L does meet the requirements:

Design parameters		
Kv factor		0.85
Kx factor		0.85
Ky factor		1.00
Kz factor		1.00
Ane/Ag		1.00
Fy	MPa	300.00
Fu	MPa	450.00

Maximum L/r ratios		
L Case	Compr.	Tension
C1	200	300
C2	200	300
C3	200	300

Element	Length (m)	L.C.	Force (kN)	L/R	Crit Axis	Section	Pc (MPa)	σc (MPa)	Result
GROUP 5	Angles (Equal leg)								
4-5	3.487	C2	-6.14	299	V	50x50x3	270.0	20.6	OK
6-7	3.488	C2	-3.72	299	V	50x50x3	270.0	12.5	OK
8-9	3.488	C2	-1.13	299	V	50x50x3	270.0	3.8	OK
18-19	3.487	C2	-6.29	299	V	50x50x3	270.0	21.1	OK
20-21	3.488	C2	-3.91	299	V	50x50x3	270.0	13.1	OK
22-23	3.488	C2	-1.32	299	V	50x50x3	270.0	4.4	OK
32-33	3.487	C2	-6.48	299	V	50x50x3	270.0	21.7	OK
34-35	3.488	C2	-4.10	299	V	50x50x3	270.0	13.8	OK
36-37	3.488	C2	-1.52	299	V	50x50x3	270.0	5.1	OK
9-12	3.488	C2	-1.51	299	V	50x50x3	270.0	5.1	OK
11-14	3.488	C2	-4.09	299	V	50x50x3	270.0	13.7	OK
13-18	3.488	C2	-6.48	299	V	50x50x3	270.0	21.7	OK
23-26	3.488	C2	-1.31	299	V	50x50x3	270.0	4.4	OK
25-28	3.488	C2	-3.90	299	V	50x50x3	270.0	13.1	OK
27-32	3.488	C2	-6.29	299	V	50x50x3	270.0	21.1	OK
37-40	3.488	C2	-1.12	299	V	50x50x3	270.0	3.8	OK
39-42	3.488	C2	-3.71	299	V	50x50x3	270.0	12.4	OK
41-46	3.488	C2	-6.14	299	V	50x50x3	270.0	20.6	OK

The length of the members remain the same, while the radius of gyration of the heavier section is smaller than that of the lighter section. In other words, the heavier section is more slender. This can be seen in the extract from the Prokon Section Database.

Designation	h,b (mm)	t (mm)	r1 (mm)	r2 (mm)	m (kg/m	A E3	Ix E6	Zx E3	rx (mm)	Iu E6	Zu E3	ru (mm)	Iv E6	Zv E3	rv (mm)	J E3	ay (mm)	Nor pre
25x25x3	25	3	3.5	2	1.11	.142	.008	.448	7.49	.013	.714	9.43	.003	.324	4.83	.476	7.21	☐
25x25x5	25	5	3.5	2	1.77	.226	.012	.708	7.30	.019	1.07	9.14	.005	.462	4.80	1.98	7.98	☐
																		☐
30x30x3	30	3	5	2.5	1.36	.174	.014	.649	8.99	.022	1.05	11.3	.006	.496	5.81	.635	8.35	☐
30x30x5	30	5	5	2.5	2.18	.278	.022	1.04	8.83	.034	1.61	11.1	.009	.706	5.75	2.58	9.18	☐
																		☐
40x40x3	40	3	6	3	1.85	.235	.035	1.18	12.1	.055	1.93	15.3	.014	.951	7.84	.882	10.7	☐
40x40x4	40	4	6	3	2.42	.308	.045	1.55	12.1	.071	2.51	15.2	.019	1.17	7.77	1.92	11.2	☐
40x40x5	40	5	6	3	2.97	.379	.054	1.91	12.0	.086	3.04	15.1	.023	1.38	7.73	3.56	11.6	☐
																		☐
45x45x3	45	3	7	3.5	2.10	.268	.050	1.52	13.7	.079	2.49	17.2	.021	1.25	8.88	1.06	11.9	☐
45x45x4	45	4	7	3.5	2.74	.349	.064	1.97	13.6	.102	3.20	17.1	.027	1.53	8.76	2.27	12.3	☐
45x45x5	45	5	7	3.5	3.38	.430	.078	2.43	13.5	.124	3.90	17.0	.033	1.80	8.71	4.17	12.8	☐
																		☐
50x50x3	50	3	7	3.5	2.34	.298	.070	1.89	15.3	.110	3.12	19.2	.029	1.58	9.92	1.15	13.1	☐
50x50x4	50	4	7	3.5	3.06	.389	.090	2.46	15.2	.142	4.02	19.1	.037	1.94	9.79	2.48	13.6	☐
50x50x5	50	5	7	3.5	3.77	.480	.110	3.05	15.1	.174	4.92	19.0	.045	2.29	9.73	4.58	14.0	☐
50x50x6	50	6	7	3.5	4.47	.569	.128	3.61	15.0	.203	5.75	18.9	.053	2.61	9.68	7.62	14.5	☐
50x50x8	50	8	7	3.5	5.82	.741	.163	4.68	14.8	.257	7.27	18.6	.069	3.19	9.63	17.0	15.2	☐

The slenderness ratio of a member is the ratio of the effective length, to the corresponding radius of gyration.

The maximum L/r ratios can be set in the Input tab, as shown below.

F9 Maximum L/r ratios

L Case	Compr.	Tension	X
C1	200	300	x
C2	200	300	x
C3	200	300	x

Guidelines from SANS 10162-1: 2011

Section 10.4 of the code states the following:

- *The maximum slenderness ratio of a member in compression shall not exceed 200.*
- *The maximum slenderness ratio of a member in tension shall not exceed 300. This limit may be waived if other means are provided to control flexibility, sag, vibration and slack in a manner commensurate with the service conditions of the structure, or if it can be shown that such factors are not detrimental to the performance of the structure or of the assembly of which the member is a part.*

Conclusion

The user can choose to waive the limiting tension slenderness ratio or choose to use the lighter section.