9
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→ EXEMPLO 2 - PELA ANTIGA NORMA

- **Carga de Colapso:**

```
model:

 max =P;
+ 1.0000 * N1 + 0.7205 * N2 = 0;
- 1.0000 * N1 + 1.0000 * N3 - 0.7205 * N4 + 0.7205 * N25 = 0 ;
+ 0.6934 * N4 + 0.6934 * N25 + 1.0000 * N44 = 0 ;
- 1.0000 * N3 + 1.0000 * N5 + 0.7205 * N6 - 0.7205 * N26 = 0 ;
+ 0.6934 * N6 + 1.0000 * N7 + 0.6934 * N26 = 0 ;
- 1.0000 * N5 + 1.0000 * N8 - 0.7205 * N9 + 0.7205 * N29 = 0 ;
+ 0.6934 * N9 + 0.6934 * N29 + 1.0000 * N49 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7205 * N11 - 0.7205 * N30 = 0 ;
+ 0.6934 * N11 + 0.6934 * N30 + 1.0000 * N52 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7205 * N13 + 0.7205 * N33 = 0 ;
+ 0.6934 * N13 + 0.6934 * N33 + 1.0000 * N55 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7205 * N15 - 0.7205 * N34 = 0 ;
+ 0.6934 * N15 + 0.6934 * N34 + 1.0000 * N58 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7205 * N17 + 0.7205 * N37 = 0 ;
+ 0.6934 * N17 + 0.6934 * N37 + 1.0000 * N61 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7205 * N19 - 0.7205 * N38 = 0 ;
+ 0.6934 * N19 + 0.6934 * N38 + 1.0000 * N64 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7205 * N21 + 0.7205 * N41 = 0 ;
+ 0.6934 * N21 + 0.6934 * N41 + 1.0000 * N67 = 0 ;
- 1.0000 * N20 - 0.7205 * N42 = 0;
- 0.7205 * N2 + 0.7205 * N4 - 0.7205 * N23 + 0.7205 * N24 = 0 ;
- 0.6934 * N2 - 0.6934 * N4 + 0.6934 * N23 + 0.6934 * N24 = 0 ;
- 0.7205 * N25 + 0.7205 * N26 - 0.7205 * N45 + 0.7205 * N47 = 0 ;
- 0.6934 * N25 - 0.6934 * N26 + 0.6934 * N45 + 0.6934 * N47 = 0 ;
- 0.7205 * N6 + 0.7205 * N9 - 0.7205 * N27 + 0.7205 * N28 = 0 ;
- 0.6934 * N6 - 0.6934 * N9 + 0.6934 * N27 + 0.6934 * N28 = 0 ;
- 0.7205 * N29 + 0.7205 * N30 - 0.7205 * N50 + 0.7205 * N53 = 0 ;
- 0.6934 * N29 - 0.6934 * N30 + 0.6934 * N50 + 0.6934 * N53 = 0 ;
- 0.7205 * N11 + 0.7205 * N13 - 0.7205 * N31 + 0.7205 * N32 = 0 ;
- 0.6934 * N11 - 0.6934 * N13 + 0.6934 * N31 + 0.6934 * N32 = 0 ;
- 0.7205 * N33 + 0.7205 * N34 - 0.7205 * N56 + 0.7205 * N59 = 0 ;
- 0.6934 * N33 - 0.6934 * N34 + 0.6934 * N56 + 0.6934 * N59 = 0 ;
- 0.7205 * N15 + 0.7205 * N17 - 0.7205 * N35 + 0.7205 * N36 = 0 ;
- 0.6934 * N15 - 0.6934 * N17 + 0.6934 * N35 + 0.6934 * N36 = 0 ;
- 0.7205 * N37 + 0.7205 * N38 - 0.7205 * N62 + 0.7205 * N65 = 0 ;
- 0.6934 * N37 - 0.6934 * N38 + 0.6934 * N62 + 0.6934 * N65 = 0 ;
- 0.7205 * N19 + 0.7205 * N21 - 0.7205 * N39 + 0.7205 * N40 = 0 ;
- 0.6934 * N19 - 0.6934 * N21 + 0.6934 * N39 + 0.6934 * N40 = 0 ;
- 0.7205 * N41 + 0.7205 * N42 - 0.7205 * N68 + 0.7205 * N70 = 0 ;
- 0.6934 * N41 - 0.6934 * N42 + 0.6934 * N68 + 0.6934 * N70 = 0 ;
+ 0.7205 * N23 + 1.0000 * N46 = 0 ;
```

```
- 130 - 0.6934 * N23 - 1.0000 * N43 = 0 ;
- 0.7205 * N24 + 0.7205 * N45 - 1.0000 * N46 + 1.0000 * N48 = 0 ;
- 260 - 0.6934 * N24 - 1.0000 * N44 - 0.6934 * N45 = 0 ;
+ 0.7205 * N27 - 0.7205 * N47 - 1.0000 * N48 + 1.0000 * N51 = 0 ;
- 260 - 1.0000 * N7 - 0.6934 * N27 - 0.6934 * N47 = 0 ;
- 0.7205 * N28 + 0.7205 * N50 - 1.0000 * N51 + 1.0000 * N54 = 0 ;
- 0.67 * P - 260 - 0.6934 * N28 - 1.0000 * N49 - 0.6934 * N50 = 0;
+ 0.7205 * N31 - 0.7205 * N53 - 1.0000 * N54 + 1.0000 * N57 = 0 ;
- 0.33 * P - 260 - 0.6934 * N31 - 1.0000 * N52 - 0.6934 * N53 = 0;
- 0.7205 * N32 + 0.7205 * N56 - 1.0000 * N57 + 1.0000 * N60 = 0 ;
- 260 - 0.6934 * N32 - 1.0000 * N55 - 0.6934 * N56 = 0 ;
+ 0.7205 * N35 - 0.7205 * N59 - 1.0000 * N60 + 1.0000 * N63 = 0 ;
- 0.33 * P - 260 - 0.6934 * N35 - 1.0000 * N58 - 0.6934 * N59 = 0;
- 0.7205 * N36 + 0.7205 * N62 - 1.0000 * N63 + 1.0000 * N66 = 0 ;
- 0.67 * P - 260 - 0.6934 * N36 - 1.0000 * N61 - 0.6934 * N62 = 0;
+ 0.7205 * N39 - 0.7205 * N65 - 1.0000 * N66 + 1.0000 * N69 = 0 ;
- 260 - 0.6934 * N39 - 1.0000 * N64 - 0.6934 * N65 = 0 ;
- 0.7205 * N40 + 0.7205 * N68 - 1.0000 * N69 + 1.0000 * N71 = 0 ;
- 260 - 0.6934 * N40 - 1.0000 * N67 - 0.6934 * N68 = 0 ;
- 0.7205 * N70 - 1.0000 * N71 = 0 ;
- 130 - 1.0000 * N22 - 0.6934 * N70 = 0 ;

@BND(-708275.5059,N1,408956.0000);
@BND(-209344.1819,N2,0.0000);
@BND(-708275.5059,N3,408956.0000);
@BND(-209344.1819,N4,0.0000);
@BND(-708275.5059,N5,408956.0000);
@BND(-209344.1819,N6,0.0000);
@BND(0.0000,N7,90024.0000);
@BND(-708275.5059,N8,408956.0000);
@BND(-209344.1819,N9,0.0000);
@BND(-708275.5059,N10,408956.0000);
@BND(-209344.1819,N11,0.0000);
@BND(-708275.5059,N12,408956.0000);
@BND(-209344.1819,N13,0.0000);
@BND(-708275.5059,N14,408956.0000);
@BND(-209344.1819,N15,0.0000);
@BND(-708275.5059,N16,408956.0000);
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@BND(-708275.5059,N18,408956.0000);
@BND(-209344.1819,N19,0.0000);
@BND(-708275.5059,N20,408956.0000);
@BND(-209344.1819,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-209344.1819,N23,0.0000);
@BND(-209344.1819,N24,0.0000);
@BND(-209344.1819,N25,0.0000);
@BND(-209344.1819,N26,0.0000);
@BND(-209344.1819,N27,0.0000);
@BND(-209344.1819,N28,0.0000);
@BND(-209344.1819,N29,0.0000);
@BND(-209344.1819,N30,0.0000);
@BND(-209344.1819,N31,0.0000);
@BND(-209344.1819,N32,0.0000);
@BND(-209344.1819,N33,0.0000);
@BND(-209344.1819,N34,0.0000);
@BND(-209344.1819,N35,0.0000);
@BND(-209344.1819,N36,0.0000);
@BND(-209344.1819,N37,0.0000);
@BND(-209344.1819,N38,0.0000);
@BND(-209344.1819,N39,0.0000);
```

```
@BND(-209344.1819,N40,0.0000);
@BND(-209344.1819,N41,0.0000);
@BND(-209344.1819,N42,0.0000);
@BND(0.0000,N43,0.0000);
@BND(0.0000,N44,90024.0000);
@BND(-209344.1819,N45,0.0000);
@BND(-320843.5059,N46,21524.0000);
@BND(-209344.1819,N47,0.0000);
@BND(-320843.5059,N48,21524.0000);
@BND(0.0000,N49,90024.0000);
@BND(-209344.1819,N50,0.0000);
@BND(-320843.5059,N51,21524.0000);
@BND(0.0000,N52,90024.0000);
@BND(-209344.1819,N53,0.0000);
@BND(-320843.5059,N54,21524.0000);
@BND(0.0000,N55,90024.0000);
@BND(-209344.1819,N56,0.0000);
@BND(-320843.5059,N57,21524.0000);
@BND(0.0000,N58,90024.0000);
@BND(-209344.1819,N59,0.0000);
@BND(-320843.5059,N60,21524.0000);
@BND(0.0000,N61,90024.0000);
@BND(-209344.1819,N62,0.0000);
@BND(-320843.5059,N63,21524.0000);
@BND(0.0000,N64,90024.0000);
@BND(-209344.1819,N65,0.0000);
@BND(-320843.5059,N66,21524.0000);
@BND(0.0000,N67,90024.0000);
@BND(-209344.1819,N68,0.0000);
@BND(-320843.5059,N69,21524.0000);
@BND(-209344.1819,N70,0.0000);
@BND(-320843.5059,N71,21524.0000);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N70);
@FREE(N71);

END
```

- **Resultado da Carga de Colapso:**

```
Global optimal solution found at step:            30
 Objective value:                           88984.00

                    Variable           Value        Reduced Cost
                           P        88984.00          0.0000000
                          N1        93812.55          0.0000000
                          N2       -130204.8          0.0000000
                          N3        187084.8          0.0000000
                          N4       -187.4820          0.0000000
                         N25       -129642.3          0.0000000
                         N44        90024.00         -1.000000
                          N5        280221.9          0.0000000
                          N6       -129267.4          0.0000000
                         N26        0.0000000          0.0000000
                          N7        89634.00          0.0000000
                          N8        311139.5          0.0000000
                          N9        0.0000000          0.0000000
                         N29       -42911.34          0.0000000
                         N49        29754.72          0.0000000
                         N10        311274.6          0.0000000
                         N11       -187.4820          0.0000000
                         N30        0.0000000          0.0000000
                         N52        130.0000          0.0000000
                         N12        311274.6          0.0000000
                         N13        0.0000000          0.0000000
                         N33        0.0000000          0.0000000
                         N55        0.0000000          0.0000000
                         N14        311139.5          0.0000000
                         N15        0.0000000          0.0000000
                         N34       -187.4820          0.0000000
                         N58        130.0000          0.0000000
                         N16        280221.9          0.0000000
                         N17       -42911.34          0.0000000
                         N37        0.0000000          0.0000000
                         N61        29754.72          0.0000000
                         N18        187084.8          0.0000000
                         N19        0.0000000          0.0000000
                         N38       -129267.4          0.0000000
                         N64        89634.00          0.0000000
                         N20        93812.55          0.0000000
                         N21       -129642.3          0.0000000
                         N41       -187.4820          0.0000000
                         N67        90024.00          0.0000000
                         N42       -130204.8          0.0000000
                         N23       -187.4820          0.0000000
                         N24       -130204.8          0.0000000
                         N45        0.0000000         -0.6934000
                         N47       -129642.3          0.0000000
                         N27        0.0000000          0.0000000
                         N28       -129267.4          0.0000000
                         N50        0.0000000          0.0000000
                         N53       -42911.34          0.0000000
                         N31        0.0000000          0.0000000
                         N32       -187.4820          0.0000000
                         N56       -187.4820          0.0000000
                         N59        0.0000000          0.0000000
```

N35	-42911.34	0.0000000
N36	0.0000000	0.0000000
N62	-129267.4	0.0000000
N65	0.0000000	0.0000000
N39	-129642.3	0.0000000
N40	0.0000000	0.0000000
N68	-130204.8	0.0000000
N70	-187.4820	0.0000000
N46	135.0808	0.0000000
N43	0.0000000	1.000000
N48	-93677.47	0.0000000
N51	-187084.8	0.0000000
N54	-280221.9	0.0000000
N57	-311139.5	0.0000000
N60	-311139.5	0.0000000
N63	-280221.9	0.0000000
N66	-187084.8	0.0000000
N69	-93677.47	0.0000000
N71	135.0808	0.0000000
N22	0.0000000	0.0000000

→ **EXEMPLO 2 - PELA NOVA NORMA**

- **Carga de Colapso:**

```
model:

 max =P;
+ 1.0000 * N1 + 0.7205 * N2 = 0;
- 1.0000 * N1 + 1.0000 * N3 - 0.7205 * N4 + 0.7205 * N25 = 0 ;
+ 0.6934 * N4 + 0.6934 * N25 + 1.0000 * N44 = 0 ;
- 1.0000 * N3 + 1.0000 * N5 + 0.7205 * N6 - 0.7205 * N26 = 0 ;
+ 0.6934 * N6 + 1.0000 * N7 + 0.6934 * N26 = 0 ;
- 1.0000 * N5 + 1.0000 * N8 - 0.7205 * N9 + 0.7205 * N29 = 0 ;
+ 0.6934 * N9 + 0.6934 * N29 + 1.0000 * N49 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7205 * N11 - 0.7205 * N30 = 0 ;
+ 0.6934 * N11 + 0.6934 * N30 + 1.0000 * N52 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7205 * N13 + 0.7205 * N33 = 0 ;
+ 0.6934 * N13 + 0.6934 * N33 + 1.0000 * N55 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7205 * N15 - 0.7205 * N34 = 0 ;
+ 0.6934 * N15 + 0.6934 * N34 + 1.0000 * N58 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7205 * N17 + 0.7205 * N37 = 0 ;
+ 0.6934 * N17 + 0.6934 * N37 + 1.0000 * N61 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7205 * N19 - 0.7205 * N38 = 0 ;
+ 0.6934 * N19 + 0.6934 * N38 + 1.0000 * N64 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7205 * N21 + 0.7205 * N41 = 0 ;
+ 0.6934 * N21 + 0.6934 * N41 + 1.0000 * N67 = 0 ;
- 1.0000 * N20 - 0.7205 * N42 = 0;
- 0.7205 * N2 + 0.7205 * N4 - 0.7205 * N23 + 0.7205 * N24 = 0 ;
- 0.6934 * N2 - 0.6934 * N4 + 0.6934 * N23 + 0.6934 * N24 = 0 ;
- 0.7205 * N25 + 0.7205 * N26 - 0.7205 * N45 + 0.7205 * N47 = 0 ;
- 0.6934 * N25 - 0.6934 * N26 + 0.6934 * N45 + 0.6934 * N47 = 0 ;
- 0.7205 * N6 + 0.7205 * N9 - 0.7205 * N27 + 0.7205 * N28 = 0 ;
- 0.6934 * N6 - 0.6934 * N9 + 0.6934 * N27 + 0.6934 * N28 = 0 ;
- 0.7205 * N29 + 0.7205 * N30 - 0.7205 * N50 + 0.7205 * N53 = 0 ;
- 0.6934 * N29 - 0.6934 * N30 + 0.6934 * N50 + 0.6934 * N53 = 0 ;
- 0.7205 * N11 + 0.7205 * N13 - 0.7205 * N31 + 0.7205 * N32 = 0 ;
- 0.6934 * N11 - 0.6934 * N13 + 0.6934 * N31 + 0.6934 * N32 = 0 ;
- 0.7205 * N33 + 0.7205 * N34 - 0.7205 * N56 + 0.7205 * N59 = 0 ;
- 0.6934 * N33 - 0.6934 * N34 + 0.6934 * N56 + 0.6934 * N59 = 0 ;
- 0.7205 * N15 + 0.7205 * N17 - 0.7205 * N35 + 0.7205 * N36 = 0 ;
- 0.6934 * N15 - 0.6934 * N17 + 0.6934 * N35 + 0.6934 * N36 = 0 ;
- 0.7205 * N37 + 0.7205 * N38 - 0.7205 * N62 + 0.7205 * N65 = 0 ;
- 0.6934 * N37 - 0.6934 * N38 + 0.6934 * N62 + 0.6934 * N65 = 0 ;
- 0.7205 * N19 + 0.7205 * N21 - 0.7205 * N39 + 0.7205 * N40 = 0 ;
- 0.6934 * N19 - 0.6934 * N21 + 0.6934 * N39 + 0.6934 * N40 = 0 ;
- 0.7205 * N41 + 0.7205 * N42 - 0.7205 * N68 + 0.7205 * N70 = 0 ;
- 0.6934 * N41 - 0.6934 * N42 + 0.6934 * N68 + 0.6934 * N70 = 0 ;
+ 0.7205 * N23 + 1.0000 * N46 = 0 ;
- 130 - 0.6934 * N23 - 1.0000 * N43 = 0 ;
- 0.7205 * N24 + 0.7205 * N45 - 1.0000 * N46 + 1.0000 * N48 = 0 ;
- 260 - 0.6934 * N24 - 1.0000 * N44 - 0.6934 * N45 = 0 ;
+ 0.7205 * N27 - 0.7205 * N47 - 1.0000 * N48 + 1.0000 * N51 = 0 ;
- 260 - 1.0000 * N7 - 0.6934 * N27 - 0.6934 * N47 = 0 ;
- 0.7205 * N28 + 0.7205 * N50 - 1.0000 * N51 + 1.0000 * N54 = 0 ;
- 0.67 * P - 260 - 0.6934 * N28 - 1.0000 * N49 - 0.6934 * N50 = 0;
+ 0.7205 * N31 - 0.7205 * N53 - 1.0000 * N54 + 1.0000 * N57 = 0 ;
- 0.33 * P - 260 - 0.6934 * N31 - 1.0000 * N52 - 0.6934 * N53 = 0;
- 0.7205 * N32 + 0.7205 * N56 - 1.0000 * N57 + 1.0000 * N60 = 0 ;
- 260 - 0.6934 * N32 - 1.0000 * N55 - 0.6934 * N56 = 0 ;
```

```
+ 0.7205 * N35 - 0.7205 * N59 - 1.0000 * N60 + 1.0000 * N63 = 0 ;
- 0.33 * P - 260 - 0.6934 * N35 - 1.0000 * N58 - 0.6934 * N59 = 0;
- 0.7205 * N36 + 0.7205 * N62 - 1.0000 * N63 + 1.0000 * N66 = 0 ;
- 0.67 * P - 260 - 0.6934 * N36 - 1.0000 * N61 - 0.6934 * N62 = 0;
+ 0.7205 * N39 - 0.7205 * N65 - 1.0000 * N66 + 1.0000 * N69 = 0 ;
- 260 - 0.6934 * N39 - 1.0000 * N64 - 0.6934 * N65 = 0 ;
- 0.7205 * N40 + 0.7205 * N68 - 1.0000 * N69 + 1.0000 * N71 = 0 ;
- 260 - 0.6934 * N40 - 1.0000 * N67 - 0.6934 * N68 = 0 ;
- 0.7205 * N70 - 1.0000 * N71 = 0 ;
- 130 - 1.0000 * N22 - 0.6934 * N70 = 0 ;

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@BND(-209344.1819,N2,0.0000);
@BND(-708275.5059,N3,408956.0000);
@BND(-209344.1819,N4,0.0000);
@BND(-708275.5059,N5,408956.0000);
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@BND(0.0000,N7,108960.8400);
@BND(-708275.5059,N8,408956.0000);
@BND(-209344.1819,N9,0.0000);
@BND(-708275.5059,N10,408956.0000);
@BND(-209344.1819,N11,0.0000);
@BND(-708275.5059,N12,408956.0000);
@BND(-209344.1819,N13,0.0000);
@BND(-708275.5059,N14,408956.0000);
@BND(-209344.1819,N15,0.0000);
@BND(-708275.5059,N16,408956.0000);
@BND(-209344.1819,N17,0.0000);
@BND(-708275.5059,N18,408956.0000);
@BND(-209344.1819,N19,0.0000);
@BND(-708275.5059,N20,408956.0000);
@BND(-209344.1819,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-209344.1819,N23,0.0000);
@BND(-209344.1819,N24,0.0000);
@BND(-209344.1819,N25,0.0000);
@BND(-209344.1819,N26,0.0000);
@BND(-209344.1819,N27,0.0000);
@BND(-209344.1819,N28,0.0000);
@BND(-209344.1819,N29,0.0000);
@BND(-209344.1819,N30,0.0000);
@BND(-209344.1819,N31,0.0000);
@BND(-209344.1819,N32,0.0000);
@BND(-209344.1819,N33,0.0000);
@BND(-209344.1819,N34,0.0000);
@BND(-209344.1819,N35,0.0000);
@BND(-209344.1819,N36,0.0000);
@BND(-209344.1819,N37,0.0000);
@BND(-209344.1819,N38,0.0000);
@BND(-209344.1819,N39,0.0000);
@BND(-209344.1819,N40,0.0000);
@BND(-209344.1819,N41,0.0000);
@BND(-209344.1819,N42,0.0000);
@BND(0.0000,N43,0.0000);
@BND(0.0000,N44,108960.8400);
@BND(-209344.1819,N45,0.0000);
@BND(-320843.5059,N46,21524.0000);
@BND(-209344.1819,N47,0.0000);
@BND(-320843.5059,N48,21524.0000);
@BND(0.0000,N49,108960.8400);
@BND(-209344.1819,N50,0.0000);
```

```
@BND(-320843.5059,N51,21524.0000);
@BND(0.0000,N52,108960.8400);
@BND(-209344.1819,N53,0.0000);
@BND(-320843.5059,N54,21524.0000);
@BND(0.0000,N55,108960.8400);
@BND(-209344.1819,N56,0.0000);
@BND(-320843.5059,N57,21524.0000);
@BND(0.0000,N58,108960.8400);
@BND(-209344.1819,N59,0.0000);
@BND(-320843.5059,N60,21524.0000);
@BND(0.0000,N61,108960.8400);
@BND(-209344.1819,N62,0.0000);
@BND(-320843.5059,N63,21524.0000);
@BND(0.0000,N64,108960.8400);
@BND(-209344.1819,N65,0.0000);
@BND(-320843.5059,N66,21524.0000);
@BND(0.0000,N67,108960.8400);
@BND(-209344.1819,N68,0.0000);
@BND(-320843.5059,N69,21524.0000);
@BND(-209344.1819,N70,0.0000);
@BND(-320843.5059,N71,21524.0000);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N70);
@FREE(N71);

END
```

- **Resultado da Carga de Colapso:**

```
Global optimal solution found at step:             32
 Objective value:                            104501.5

                  Variable           Value      Reduced Cost
                         P        104501.5         0.0000000
                        N1        109936.5         0.0000000
                        N2       -152583.6         0.0000000
                        N3        219332.6         0.0000000
                        N4       -187.4820         0.0000000
                       N25       -152021.1         0.0000000
                       N44        105541.5         0.0000000
                        N5        328593.7         0.0000000
                        N6       -151646.2         0.0000000
                       N26        0.0000000         0.0000000
                        N7        105151.5         0.0000000
                        N8        372582.4         0.0000000
                        N9        0.0000000         0.0000000
                       N29       -61053.03         0.0000000
                       N49        42334.17         0.0000000
                       N10        408956.0         0.0000000
                       N11       -61240.51         0.0000000
                       N30       -10756.69         0.0000000
                       N52        49922.86         0.0000000
                       N12        408956.0        -0.1445026
                       N13       -61053.03         0.0000000
                       N33       -61053.03         0.0000000
                       N55        84668.34         0.0000000
                       N14        372582.4         0.0000000
                       N15       -10756.69         0.0000000
                       N34       -61240.51         0.0000000
                       N58        49922.86         0.0000000
                       N16        328593.7         0.0000000
                       N17       -61053.03         0.0000000
                       N37        0.0000000         0.0000000
                       N61        42334.17         0.0000000
                       N18        219332.6         0.0000000
                       N19        0.0000000         0.0000000
                       N38       -151646.2         0.0000000
                       N64        105151.5         0.0000000
                       N20        109936.5         0.0000000
                       N21       -152021.1         0.0000000
                       N41       -187.4820         0.0000000
                       N67        105541.5         0.0000000
                       N42       -152583.6         0.0000000
                       N23       -187.4820         0.0000000
                       N24       -152583.6         0.0000000
                       N45        0.0000000         0.0000000
                       N47       -152021.1         0.0000000
                       N27        0.0000000         0.0000000
                       N28       -151646.2         0.0000000
                       N50       -10756.69         0.0000000
                       N53       -61053.03         0.0000000
                       N31       -61053.03         0.0000000
                       N32       -61240.51         0.0000000
                       N56       -61240.51         0.0000000
                       N59       -61053.03         0.0000000
                       N35       -61053.03         0.0000000
                       N36       -10756.69         0.0000000
```

N62	-151646.2	0.0000000
N65	0.0000000	0.0000000
N39	-152021.1	0.0000000
N40	0.0000000	0.0000000
N68	-152583.6	0.0000000
N70	-187.4820	0.0000000
N46	135.0808	0.0000000
N43	0.0000000	0.0000000
N48	-109801.4	0.0000000
N51	-219332.6	0.0000000
N54	-320843.5	0.0000000
N57	-320843.5	0.0000000
N60	-320843.5	0.1445026
N63	-320843.5	0.0000000
N66	-219332.6	0.0000000
N69	-109801.4	0.0000000
N71	135.0808	0.0000000
N22	0.0000000	0.0000000

→ **EXEMPLO 2 - PELA ANTIGA NORMA**

- **Dimensionamento para P = 89 kN:**

```
model:

DATA:
P = 63560;
ENDDATA

 min = (A1 * 30 + A3 * 30 + A5 * 30 + A8 * 30 + A10 * 30 + A12 *
30 + A14 * 30 + A16 * 30 + A18 * 30 + A20 * 30 + A46 * 30 + A48 *
30 + A51 * 30 + A54 * 30 + A57 * 30 + A60 * 30 + A63 * 30 + A66 *
30 + A69 * 30 + A71 * 30 + A44 * 28.87 + A7 * 28.87 + A49 * 28.87
+ A52 * 28.87 + A55 * 28.87 + A58 * 28.87 + A61 * 28.87 + A64 *
28.87 + A67 * 28.87 );

+ 1.0000 * N1 + 0.7205 * N2 = 0;
- 1.0000 * N1 + 1.0000 * N3 - 0.7205 * N4 + 0.7205 * N25 = 0 ;
+ 0.6934 * N4 + 0.6934 * N25 + 1.0000 * N44 = 0 ;
- 1.0000 * N3 + 1.0000 * N5 + 0.7205 * N6 - 0.7205 * N26 = 0 ;
+ 0.6934 * N6 + 1.0000 * N7 + 0.6934 * N26 = 0 ;
- 1.0000 * N5 + 1.0000 * N8 - 0.7205 * N9 + 0.7205 * N29 = 0 ;
+ 0.6934 * N9 + 0.6934 * N29 + 1.0000 * N49 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7205 * N11 - 0.7205 * N30 = 0 ;
+ 0.6934 * N11 + 0.6934 * N30 + 1.0000 * N52 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7205 * N13 + 0.7205 * N33 = 0 ;
+ 0.6934 * N13 + 0.6934 * N33 + 1.0000 * N55 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7205 * N15 - 0.7205 * N34 = 0 ;
+ 0.6934 * N15 + 0.6934 * N34 + 1.0000 * N58 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7205 * N17 + 0.7205 * N37 = 0 ;
+ 0.6934 * N17 + 0.6934 * N37 + 1.0000 * N61 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7205 * N19 - 0.7205 * N38 = 0 ;
+ 0.6934 * N19 + 0.6934 * N38 + 1.0000 * N64 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7205 * N21 + 0.7205 * N41 = 0 ;
+ 0.6934 * N21 + 0.6934 * N41 + 1.0000 * N67 = 0 ;
- 1.0000 * N20 - 0.7205 * N42 = 0;
- 0.7205 * N2 + 0.7205 * N4 - 0.7205 * N23 + 0.7205 * N24 = 0 ;
- 0.6934 * N2 - 0.6934 * N4 + 0.6934 * N23 + 0.6934 * N24 = 0 ;
- 0.7205 * N25 + 0.7205 * N26 - 0.7205 * N45 + 0.7205 * N47 = 0 ;
- 0.6934 * N25 - 0.6934 * N26 + 0.6934 * N45 + 0.6934 * N47 = 0 ;
- 0.7205 * N6 + 0.7205 * N9 - 0.7205 * N27 + 0.7205 * N28 = 0 ;
- 0.6934 * N6 - 0.6934 * N9 + 0.6934 * N27 + 0.6934 * N28 = 0 ;
- 0.7205 * N29 + 0.7205 * N30 - 0.7205 * N50 + 0.7205 * N53 = 0 ;
- 0.6934 * N29 - 0.6934 * N30 + 0.6934 * N50 + 0.6934 * N53 = 0 ;
- 0.7205 * N11 + 0.7205 * N13 - 0.7205 * N31 + 0.7205 * N32 = 0 ;
- 0.6934 * N11 - 0.6934 * N13 + 0.6934 * N31 + 0.6934 * N32 = 0 ;
- 0.7205 * N33 + 0.7205 * N34 - 0.7205 * N56 + 0.7205 * N59 = 0 ;
- 0.6934 * N33 - 0.6934 * N34 + 0.6934 * N56 + 0.6934 * N59 = 0 ;
- 0.7205 * N15 + 0.7205 * N17 - 0.7205 * N35 + 0.7205 * N36 = 0 ;
- 0.6934 * N15 - 0.6934 * N17 + 0.6934 * N35 + 0.6934 * N36 = 0 ;
- 0.7205 * N37 + 0.7205 * N38 - 0.7205 * N62 + 0.7205 * N65 = 0 ;
- 0.6934 * N37 - 0.6934 * N38 + 0.6934 * N62 + 0.6934 * N65 = 0 ;
- 0.7205 * N19 + 0.7205 * N21 - 0.7205 * N39 + 0.7205 * N40 = 0 ;
- 0.6934 * N19 - 0.6934 * N21 + 0.6934 * N39 + 0.6934 * N40 = 0 ;
- 0.7205 * N41 + 0.7205 * N42 - 0.7205 * N68 + 0.7205 * N70 = 0 ;
- 0.6934 * N41 - 0.6934 * N42 + 0.6934 * N68 + 0.6934 * N70 = 0 ;
```

```
+ 0.7205 * N23 + 1.0000 * N46 = 0 ;
- 130 - 0.6934 * N23 - 1.0000 * N43 = 0 ;
- 0.7205 * N24 + 0.7205 * N45 - 1.0000 * N46 + 1.0000 * N48 = 0 ;
- 260 - 0.6934 * N24 - 1.0000 * N44 - 0.6934 * N45 = 0 ;
+ 0.7205 * N27 - 0.7205 * N47 - 1.0000 * N48 + 1.0000 * N51 = 0 ;
- 260 - 1.0000 * N7 - 0.6934 * N27 - 0.6934 * N47 = 0 ;
- 0.7205 * N28 + 0.7205 * N50 - 1.0000 * N51 + 1.0000 * N54 = 0 ;
- 0.67 * P - 260 - 0.6934 * N28 - 1.0000 * N49 - 0.6934 * N50 = 0;
+ 0.7205 * N31 - 0.7205 * N53 - 1.0000 * N54 + 1.0000 * N57 = 0 ;
- 0.33 * P - 260 - 0.6934 * N31 - 1.0000 * N52 - 0.6934 * N53 =  ;
- 0.7205 * N32 + 0.7205 * N56 - 1.0000 * N57 + 1.0000 * N60 = 0 ;
- 260 - 0.6934 * N32 - 1.0000 * N55 - 0.6934 * N56 = 0 ;
+ 0.7205 * N35 - 0.7205 * N59 - 1.0000 * N60 + 1.0000 * N63 = 0 ;
- 0.33 * P - 260 - 0.6934 * N35 - 1.0000 * N58 - 0.6934 * N59 = 0;
- 0.7205 * N36 + 0.7205 * N62 - 1.0000 * N63 + 1.0000 * N66 = 0 ;
- 0.67 * P - 260 - 0.6934 * N36 - 1.0000 * N61 - 0.6934 * N62 = 0;
+ 0.7205 * N39 - 0.7205 * N65 - 1.0000 * N66 + 1.0000 * N69 = 0 ;
- 260 - 0.6934 * N39 - 1.0000 * N64 - 0.6934 * N65 = 0 ;
- 0.7205 * N40 + 0.7205 * N68 - 1.0000 * N69 + 1.0000 * N71 = 0 ;
- 260 - 0.6934 * N40 - 1.0000 * N67 - 0.6934 * N68 = 0 ;
- 0.7205 * N70 - 1.0000 * N71 = 0 ;
- 130 - 1.0000 * N22 - 0.6934 * N70 = 0 ;
N1 - 46791 * A1 <= 0;
213797.46 + 46791 * A1 + N1 >= 0;
N3 - 46791 * A3 <= 0;
213797.46 + 46791 * A3 + N3 >= 0;
N5 - 46791 * A5 <= 0;
213797.46 + 46791 * A5 + N5 >= 0;
N8 - 46791 * A8 <= 0;
213797.46 + 46791 * A8 + N8 >= 0;
N10 - 46791 * A10 <= 0;
213797.46 + 46791 * A10 + N10 >= 0;
N12 - 46791 * A12 <= 0;
213797.46 + 46791 * A12 + N12 >= 0;
N14 - 46791 * A14 <= 0;
213797.46 + 46791 * A14 + N14 >= 0;
N16 - 46791 * A16 <= 0;
213797.46 + 46791 * A16 + N16 >= 0;
N18 - 46791 * A18 <= 0;
213797.46 + 46791 * A18 + N18 >= 0;
N20 - 46791 * A20 <= 0;
213797.46 + 46791 * A20 + N20 >= 0;
N46 - 46791 * 46 <= 0;
213797.46 + 46791 * A46 + N46 >= 0;
N48 - 46791 * A48 <= 0;
213797.46 + 46791 * A48 + N48 >= 0;
N51 - 46791 * A51 <= 0;
213797.46 + 46791 * A51 + N51 >= 0;
N54 - 46791 * A54 <= 0;
213797.46 + 46791 * A54 + N54 >= 0;
N57 - 46791 * A57 <= 0;
213797.46 + 46791 * A57 + N57 >= 0;
N60 - 46791 * A60 <= 0;
213797.46 + 46791 * A60 + N60 >= 0;
N63 - 46791 * A63 <= 0;
213797.46 + 46791 * A63 + N63 >= 0;
N66 - 46791 * A66 <= 0;
213797.46 + 46791 * A66 + N66 >= 0;
N69 - 46791 * A69 <= 0;
213797.46 + 46791 * A69 + N69 >= 0;
N71 - 46791 * A71 <= 0;
```

```
213797.46 + 46791 * A71 + N71 >= 0;
N44 - 63939 * A44 <= 0;
N7 - 63939 * A7 <= 0;
N49 - 63939 * A49 <= 0;
N52 - 63939 * A52 <= 0;
N55 - 63939 * A55 <= 0;
N58 - 63939 * A58 <= 0;
N61 - 63939 * A61 <= 0;
N64 - 63939 * A64 <= 0;
N67 - 63939 * A67 <= 0;


@BND(-708275.5059,N1,408956.0000);
@BND(-209344.1819,N2,0.0000);
@BND(-708275.5059,N3,408956.0000);
@BND(-209344.1819,N4,0.0000);
@BND(-708275.5059,N5,408956.0000);
@BND(-209344.1819,N6,0.0000);
@BND(0.0000,N7,90024.0000);
@BND(-708275.5059,N8,408956.0000);
@BND(-209344.1819,N9,0.0000);
@BND(-708275.5059,N10,408956.0000);
@BND(-209344.1819,N11,0.0000);
@BND(-708275.5059,N12,408956.0000);
@BND(-209344.1819,N13,0.0000);
@BND(-708275.5059,N14,408956.0000);
@BND(-209344.1819,N15,0.0000);
@BND(-708275.5059,N16,408956.0000);
@BND(-209344.1819,N17,0.0000);
@BND(-708275.5059,N18,408956.0000);
@BND(-209344.1819,N19,0.0000);
@BND(-708275.5059,N20,408956.0000);
@BND(-209344.1819,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-209344.1819,N23,0.0000);
@BND(-209344.1819,N24,0.0000);
@BND(-209344.1819,N25,0.0000);
@BND(-209344.1819,N26,0.0000);
@BND(-209344.1819,N27,0.0000);
@BND(-209344.1819,N28,0.0000);
@BND(-209344.1819,N29,0.0000);
@BND(-209344.1819,N30,0.0000);
@BND(-209344.1819,N31,0.0000);
@BND(-209344.1819,N32,0.0000);
@BND(-209344.1819,N33,0.0000);
@BND(-209344.1819,N34,0.0000);
@BND(-209344.1819,N35,0.0000);
@BND(-209344.1819,N36,0.0000);
@BND(-209344.1819,N37,0.0000);
@BND(-209344.1819,N38,0.0000);
@BND(-209344.1819,N39,0.0000);
@BND(-209344.1819,N40,0.0000);
@BND(-209344.1819,N41,0.0000);
@BND(-209344.1819,N42,0.0000);
@BND(0.0000,N43,0.0000);
@BND(0.0000,N44,90024.0000);
@BND(-209344.1819,N45,0.0000);
@BND(-320843.5059,N46,21524.0000);
@BND(-209344.1819,N47,0.0000);
@BND(-320843.5059,N48,21524.0000);
@BND(0.0000,N49,90024.0000);
```

```
@BND(-209344.1819,N50,0.0000);
@BND(-320843.5059,N51,21524.0000);
@BND(0.0000,N52,90024.0000);
@BND(-209344.1819,N53,0.0000);
@BND(-320843.5059,N54,21524.0000);
@BND(0.0000,N55,90024.0000);
@BND(-209344.1819,N56,0.0000);
@BND(-320843.5059,N57,21524.0000);
@BND(0.0000,N58,90024.0000);
@BND(-209344.1819,N59,0.0000);
@BND(-320843.5059,N60,21524.0000);
@BND(0.0000,N61,90024.0000);
@BND(-209344.1819,N62,0.0000);
@BND(-320843.5059,N63,21524.0000);
@BND(0.0000,N64,90024.0000);
@BND(-209344.1819,N65,0.0000);
@BND(-320843.5059,N66,21524.0000);
@BND(0.0000,N67,90024.0000);
@BND(-209344.1819,N68,0.0000);
@BND(-320843.5059,N69,21524.0000);
@BND(-209344.1819,N70,0.0000);
@BND(-320843.5059,N71,21524.0000);
@BND(0.72,A1,19.2);
@BND(0.72,A3,19.2);
@BND(0.72,A5,19.2);
@BND(0.72,A8,19.2);
@BND(0.72,A10,19.2);
@BND(0.72,A12,19.2);
@BND(0.72,A14,19.2);
@BND(0.72,A16,19.2);
@BND(0.72,A18,19.2);
@BND(0.72,A20,19.2);
@BND(0.4,A46,19.2);
@BND(0.4,A48,19.2);
@BND(0.4,A51,19.2);
@BND(0.4,A54,19.2);
@BND(0.4,A57,19.2);
@BND(0.4,A60,19.2);
@BND(0.4,A63,19.2);
@BND(0.4,A66,19.2);
@BND(0.4,A69,19.2);
@BND(0.4,A71,19.2);
@BND(0.23,A44,14.4);
@BND(0.23,A7,14.4);
@BND(0.23,A49,14.4);
@BND(0.23,A52,14.4);
@BND(0.23,A55,14.4);
@BND(0.23,A58,14.4);
@BND(0.23,A61,14.4);
@BND(0.23,A64,14.4);
@BND(0.23,A67,14.4);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N70);
@FREE(N71);

END
```

- **Resultado do Dimensionamento para P = 89 kN:**

```
Global optimal solution found at step:              69
 Objective value:                             1364.317

                    Variable          Value          Reduced Cost
                           P       63560.00          0.0000000
                          A1       1.440339          0.0000000
                          A3       2.869131          0.0000000
                          A5       4.295035          0.0000000
                          A8       4.769481          0.0000000
                         A10       4.772368          0.0000000
                         A12       4.772368          0.0000000
                         A14       4.769481          0.0000000
                         A16       4.295035          0.0000000
                         A18       2.869131          0.0000000
                         A20       1.440339          0.0000000
                         A46      0.4000000           30.00000
                         A48      0.4000000           30.00000
                         A51      0.4000000           30.00000
                         A54      0.4000000           30.00000
                         A57      0.4000000           30.00000
                         A60      0.4000000           30.00000
                         A63      0.4000000           30.00000
                         A66      0.4000000           30.00000
                         A69      0.4000000           30.00000
                         A71      0.4000000           30.00000
                         A44       1.010338          0.0000000
                          A7       1.004238          0.0000000
                         A49      0.3341435          0.0000000
                         A52      0.2300000           28.87000
                         A55      0.2300000           28.87000
                         A58      0.2300000           28.87000
                         A61      0.3341435          0.0000000
                         A64       1.004238          0.0000000
                         A67       1.010338          0.0000000
                          N1       67394.91          0.0000000
                          N2      -93539.08          0.0000000
                          N3       134249.5          0.0000000
                          N4      -187.4820          0.0000000
                         N25      -92976.64          0.0000000
                         N44       64600.00          0.0000000
                          N5       200969.0          0.0000000
                          N6      -92601.67          0.0000000
                         N26      0.0000000          0.0000000
                          N7       64210.00          0.0000000
                          N8       223168.8          0.0000000
                          N9      0.0000000          0.0000000
                         N29      -30811.65          0.0000000
                         N49       21364.80          0.0000000
                         N10       223303.9          0.0000000
                         N11      -187.4820          0.0000000
                         N30      0.0000000          0.0000000
                         N52       130.0000          0.0000000
                         N12       223303.9          0.0000000
                         N13      0.0000000          0.0000000
                         N33      0.0000000          0.0000000
                         N55      0.0000000          0.0000000
                         N14       223168.8          0.0000000
                         N15      0.0000000          0.0000000
```

```
N34          -187.4820              0.0000000
N58           130.0000              0.0000000
N16           200969.0              0.0000000
N17          -30811.65              0.0000000
N37          0.0000000              0.0000000
N61           21364.80              0.0000000
N18           134249.5              0.0000000
N19          0.0000000              0.0000000
N38          -92601.67              0.0000000
N64           64210.00              0.0000000
N20           67394.91              0.0000000
N21          -92976.64              0.0000000
N41          -187.4820              0.0000000
N67           64600.00              0.0000000
N42          -93539.08              0.0000000
N23          -187.4820              0.0000000
N24          -93539.08              0.0000000
N45          0.0000000          -0.1088121E-02
N47          -92976.64              0.0000000
N27          0.0000000          -0.1088121E-02
N28          -92601.67              0.0000000
N50          0.0000000          -0.7750346E-03
N53          -30811.65              0.0000000
N31          0.0000000          -0.4619478E-03
N32          -187.4820              0.0000000
N56          -187.4820              0.0000000
N59          0.0000000          -0.4619478E-03
N35          -30811.65              0.0000000
N36          0.0000000          -0.7750346E-03
N62          -92601.67              0.0000000
N65          0.0000000          -0.1088121E-02
N39          -92976.64              0.0000000
N40          0.0000000          -0.1088121E-02
N68          -93539.08              0.0000000
N70          -187.4820              0.0000000
N46           135.0808              0.0000000
N43          0.0000000           0.1117731E-02
N48          -67259.83              0.0000000
N51          -134249.5              0.0000000
N54          -200969.0              0.0000000
N57          -223168.8              0.0000000
N60          -223168.8              0.0000000
N63          -200969.0              0.0000000
N66          -134249.5              0.0000000
N69          -67259.83              0.0000000
N71           135.0808              0.0000000
N22          0.0000000           0.1117731E-02
```

- **Dimensionamento para P = 104,5 kN:**

model:

DATA:
P = 74643.57;
ENDDATA

 min = (A1 * 30 + A3 * 30 + A5 * 30 + A8 * 30 + A10 * 30 + A12 *
30 + A14 * 30 + A16 * 30 + A18 * 30 + A20 * 30 + A46 * 30 + A48 *
30 + A51 * 30 + A54 * 30 + A57 * 30 + A60 * 30 + A63 * 30 + A66 *
30 + A69 * 30 + A71 * 30 + A44 * 28.87 + A7 * 28.87 + A49 * 28.87
+ A52 * 28.87 + A55 * 28.87 + A58 * 28.87 + A61 * 28.87 + A64 *
28.87 + A67 * 28.87);

+ 1.0000 * N1 + 0.7205 * N2 = 0;
- 1.0000 * N1 + 1.0000 * N3 - 0.7205 * N4 + 0.7205 * N25 = 0 ;
+ 0.6934 * N4 + 0.6934 * N25 + 1.0000 * N44 = 0 ;
- 1.0000 * N3 + 1.0000 * N5 + 0.7205 * N6 - 0.7205 * N26 = 0 ;
+ 0.6934 * N6 + 1.0000 * N7 + 0.6934 * N26 = 0 ;
- 1.0000 * N5 + 1.0000 * N8 - 0.7205 * N9 + 0.7205 * N29 = 0 ;
+ 0.6934 * N9 + 0.6934 * N29 + 1.0000 * N49 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7205 * N11 - 0.7205 * N30 = 0 ;
+ 0.6934 * N11 + 0.6934 * N30 + 1.0000 * N52 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7205 * N13 + 0.7205 * N33 = 0 ;
+ 0.6934 * N13 + 0.6934 * N33 + 1.0000 * N55 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7205 * N15 - 0.7205 * N34 = 0 ;
+ 0.6934 * N15 + 0.6934 * N34 + 1.0000 * N58 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7205 * N17 + 0.7205 * N37 = 0 ;
+ 0.6934 * N17 + 0.6934 * N37 + 1.0000 * N61 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7205 * N19 - 0.7205 * N38 = 0 ;
+ 0.6934 * N19 + 0.6934 * N38 + 1.0000 * N64 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7205 * N21 + 0.7205 * N41 = 0 ;
+ 0.6934 * N21 + 0.6934 * N41 + 1.0000 * N67 = 0 ;
- 1.0000 * N20 - 0.7205 * N42 = 0;
- 0.7205 * N2 + 0.7205 * N4 - 0.7205 * N23 + 0.7205 * N24 = 0 ;
- 0.6934 * N2 - 0.6934 * N4 + 0.6934 * N23 + 0.6934 * N24 = 0 ;
- 0.7205 * N25 + 0.7205 * N26 - 0.7205 * N45 + 0.7205 * N47 = 0 ;
- 0.6934 * N25 - 0.6934 * N26 + 0.6934 * N45 + 0.6934 * N47 = 0 ;
- 0.7205 * N6 + 0.7205 * N9 - 0.7205 * N27 + 0.7205 * N28 = 0 ;
- 0.6934 * N6 - 0.6934 * N9 + 0.6934 * N27 + 0.6934 * N28 = 0 ;
- 0.7205 * N29 + 0.7205 * N30 - 0.7205 * N50 + 0.7205 * N53 = 0 ;
- 0.6934 * N29 - 0.6934 * N30 + 0.6934 * N50 + 0.6934 * N53 = 0 ;
- 0.7205 * N11 + 0.7205 * N13 - 0.7205 * N31 + 0.7205 * N32 = 0 ;
- 0.6934 * N11 - 0.6934 * N13 + 0.6934 * N31 + 0.6934 * N32 = 0 ;
- 0.7205 * N33 + 0.7205 * N34 - 0.7205 * N56 + 0.7205 * N59 = 0 ;
- 0.6934 * N33 - 0.6934 * N34 + 0.6934 * N56 + 0.6934 * N59 = 0 ;
- 0.7205 * N15 + 0.7205 * N17 - 0.7205 * N35 + 0.7205 * N36 = 0 ;
- 0.6934 * N15 - 0.6934 * N17 + 0.6934 * N35 + 0.6934 * N36 = 0 ;
- 0.7205 * N37 + 0.7205 * N38 - 0.7205 * N62 + 0.7205 * N65 = 0 ;
- 0.6934 * N37 - 0.6934 * N38 + 0.6934 * N62 + 0.6934 * N65 = 0 ;
- 0.7205 * N19 + 0.7205 * N21 - 0.7205 * N39 + 0.7205 * N40 = 0 ;
- 0.6934 * N19 - 0.6934 * N21 + 0.6934 * N39 + 0.6934 * N40 = 0 ;
- 0.7205 * N41 + 0.7205 * N42 - 0.7205 * N68 + 0.7205 * N70 = 0 ;
- 0.6934 * N41 - 0.6934 * N42 + 0.6934 * N68 + 0.6934 * N70 = 0 ;
+ 0.7205 * N23 + 1.0000 * N46 = 0 ;
- 130 - 0.6934 * N23 - 1.0000 * N43 = 0 ;
- 0.7205 * N24 + 0.7205 * N45 - 1.0000 * N46 + 1.0000 * N48 = 0 ;

```
- 260 - 0.6934 * N24 - 1.0000 * N44 - 0.6934 * N45 = 0 ;
+ 0.7205 * N27 - 0.7205 * N47 - 1.0000 * N48 + 1.0000 * N51 = 0 ;
- 260 - 1.0000 * N7 - 0.6934 * N27 - 0.6934 * N47 = 0 ;
- 0.7205 * N28 + 0.7205 * N50 - 1.0000 * N51 + 1.0000 * N54 = 0 ;
- 0.67 * P - 260 - 0.6934 * N28 - 1.0000 * N49 - 0.6934 * N50 = 0;
+ 0.7205 * N31 - 0.7205 * N53 - 1.0000 * N54 + 1.0000 * N57 = 0 ;
- 0.33 * P - 260 - 0.6934 * N31 - 1.0000 * N52 - 0.6934 * N53 = 0;
- 0.7205 * N32 + 0.7205 * N56 - 1.0000 * N57 + 1.0000 * N60 = 0 ;
- 260 - 0.6934 * N32 - 1.0000 * N55 - 0.6934 * N56 = 0 ;
+ 0.7205 * N35 - 0.7205 * N59 - 1.0000 * N60 + 1.0000 * N63 = 0 ;
- 0.33 * P - 260 - 0.6934 * N35 - 1.0000 * N58 - 0.6934 * N59 = 0;
- 0.7205 * N36 + 0.7205 * N62 - 1.0000 * N63 + 1.0000 * N66 = 0 ;
- 0.67 * P - 260 - 0.6934 * N36 - 1.0000 * N61 - 0.6934 * N62 = 0;
+ 0.7205 * N39 - 0.7205 * N65 - 1.0000 * N66 + 1.0000 * N69 = 0 ;
- 260 - 0.6934 * N39 - 1.0000 * N64 - 0.6934 * N65 = 0 ;
- 0.7205 * N40 + 0.7205 * N68 - 1.0000 * N69 + 1.0000 * N71 = 0 ;
- 260 - 0.6934 * N40 - 1.0000 * N67 - 0.6934 * N68 = 0 ;
- 0.7205 * N70 - 1.0000 * N71 = 0 ;
- 130 - 1.0000 * N22 - 0.6934 * N70 = 0 ;
N1 - 46791 * A1 <= 0;
213797.46 + 46791 * A1 + N1 >= 0;
N3 - 46791 * A3 <= 0;
213797.46 + 46791 * A3 + N3 >= 0;
N5 - 46791 * A5 <= 0;
213797.46 + 46791 * A5 + N5 >= 0;
N8 - 46791 * A8 <= 0;
213797.46 + 46791 * A8 + N8 >= 0;
N10 - 46791 * A10 <= 0;
213797.46 + 46791 * A10 + N10 >= 0;
N12 - 46791 * A12 <= 0;
213797.46 + 46791 * A12 + N12 >= 0;
N14 - 46791 * A14 <= 0;
213797.46 + 46791 * A14 + N14 >= 0;
N16 - 46791 * A16 <= 0;
213797.46 + 46791 * A16 + N16 >= 0;
N18 - 46791 * A18 <= 0;
213797.46 + 46791 * A18 + N18 >= 0;
N20 - 46791 * A20 <= 0;
213797.46 + 46791 * A20 + N20 >= 0;
N46 - 46791 * 46 <= 0;
213797.46 + 46791 * A46 + N46 >= 0;
N48 - 46791 * A48 <= 0;
213797.46 + 46791 * A48 + N48 >= 0;
N51 - 46791 * A51 <= 0;
213797.46 + 46791 * A51 + N51 >= 0;
N54 - 46791 * A54 <= 0;
213797.46 + 46791 * A54 + N54 >= 0;
N57 - 46791 * A57 <= 0;
213797.46 + 46791 * A57 + N57 >= 0;
N60 - 46791 * A60 <= 0;
213797.46 + 46791 * A60 + N60 >= 0;
N63 - 46791 * A63 <= 0;
213797.46 + 46791 * A63 + N63 >= 0;
N66 - 46791 * A66 <= 0;
213797.46 + 46791 * A66 + N66 >= 0;
N69 - 46791 * A69 <= 0;
213797.46 + 46791 * A69 + N69 >= 0;
N71 - 46791 * A71 <= 0;
213797.46 + 46791 * A71 + N71 >= 0;
N44 - 63939 * A44 <= 0;
N7 - 63939 * A7 <= 0;
```

```
N49 - 63939 * A49 <= 0;
N52 - 63939 * A52 <= 0;
N55 - 63939 * A55 <= 0;
N58 - 63939 * A58 <= 0;
N61 - 63939 * A61 <= 0;
N64 - 63939 * A64 <= 0;
N67 - 63939 * A67 <= 0;


@BND(-708275.5059,N1,408956.0000);
@BND(-209344.1819,N2,0.0000);
@BND(-708275.5059,N3,408956.0000);
@BND(-209344.1819,N4,0.0000);
@BND(-708275.5059,N5,408956.0000);
@BND(-209344.1819,N6,0.0000);
@BND(0.0000,N7,90024.0000);
@BND(-708275.5059,N8,408956.0000);
@BND(-209344.1819,N9,0.0000);
@BND(-708275.5059,N10,408956.0000);
@BND(-209344.1819,N11,0.0000);
@BND(-708275.5059,N12,408956.0000);
@BND(-209344.1819,N13,0.0000);
@BND(-708275.5059,N14,408956.0000);
@BND(-209344.1819,N15,0.0000);
@BND(-708275.5059,N16,408956.0000);
@BND(-209344.1819,N17,0.0000);
@BND(-708275.5059,N18,408956.0000);
@BND(-209344.1819,N19,0.0000);
@BND(-708275.5059,N20,408956.0000);
@BND(-209344.1819,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-209344.1819,N23,0.0000);
@BND(-209344.1819,N24,0.0000);
@BND(-209344.1819,N25,0.0000);
@BND(-209344.1819,N26,0.0000);
@BND(-209344.1819,N27,0.0000);
@BND(-209344.1819,N28,0.0000);
@BND(-209344.1819,N29,0.0000);
@BND(-209344.1819,N30,0.0000);
@BND(-209344.1819,N31,0.0000);
@BND(-209344.1819,N32,0.0000);
@BND(-209344.1819,N33,0.0000);
@BND(-209344.1819,N34,0.0000);
@BND(-209344.1819,N35,0.0000);
@BND(-209344.1819,N36,0.0000);
@BND(-209344.1819,N37,0.0000);
@BND(-209344.1819,N38,0.0000);
@BND(-209344.1819,N39,0.0000);
@BND(-209344.1819,N40,0.0000);
@BND(-209344.1819,N41,0.0000);
@BND(-209344.1819,N42,0.0000);
@BND(0.0000,N43,0.0000);
@BND(0.0000,N44,90024.0000);
@BND(-209344.1819,N45,0.0000);
@BND(-320843.5059,N46,21524.0000);
@BND(-209344.1819,N47,0.0000);
@BND(-320843.5059,N48,21524.0000);
@BND(0.0000,N49,90024.0000);
@BND(-209344.1819,N50,0.0000);
@BND(-320843.5059,N51,21524.0000);
@BND(0.0000,N52,90024.0000);
```

```
@BND(-209344.1819,N53,0.0000);
@BND(-320843.5059,N54,21524.0000);
@BND(0.0000,N55,90024.0000);
@BND(-209344.1819,N56,0.0000);
@BND(-320843.5059,N57,21524.0000);
@BND(0.0000,N58,90024.0000);
@BND(-209344.1819,N59,0.0000);
@BND(-320843.5059,N60,21524.0000);
@BND(0.0000,N61,90024.0000);
@BND(-209344.1819,N62,0.0000);
@BND(-320843.5059,N63,21524.0000);
@BND(0.0000,N64,90024.0000);
@BND(-209344.1819,N65,0.0000);
@BND(-320843.5059,N66,21524.0000);
@BND(0.0000,N67,90024.0000);
@BND(-209344.1819,N68,0.0000);
@BND(-320843.5059,N69,21524.0000);
@BND(-209344.1819,N70,0.0000);
@BND(-320843.5059,N71,21524.0000);
@BND(0.72,A1,19.2);
@BND(0.72,A3,19.2);
@BND(0.72,A5,19.2);
@BND(0.72,A8,19.2);
@BND(0.72,A10,19.2);
@BND(0.72,A12,19.2);
@BND(0.72,A14,19.2);
@BND(0.72,A16,19.2);
@BND(0.72,A18,19.2);
@BND(0.72,A20,19.2);
@BND(0.4,A46,19.2);
@BND(0.4,A48,19.2);
@BND(0.4,A51,19.2);
@BND(0.4,A54,19.2);
@BND(0.4,A57,19.2);
@BND(0.4,A60,19.2);
@BND(0.4,A63,19.2);
@BND(0.4,A66,19.2);
@BND(0.4,A69,19.2);
@BND(0.4,A71,19.2);
@BND(0.23,A44,14.4);
@BND(0.23,A7,14.4);
@BND(0.23,A49,14.4);
@BND(0.23,A52,14.4);
@BND(0.23,A55,14.4);
@BND(0.23,A58,14.4);
@BND(0.23,A61,14.4);
@BND(0.23,A64,14.4);
@BND(0.23,A67,14.4);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N70);
@FREE(N71);

END
```

- **Resultado do Dimensionamento para P = 104,5 kN:**

```
Global optimal solution found at step:              68
 Objective value:                             1615.647

                Variable          Value        Reduced Cost
                     P          74643.57        0.0000000
                    A1          1.686471        0.0000000
                    A3          3.361394        0.0000000
                    A5          5.033430        0.0000000
                    A8          5.589100        0.0000000
                   A10          5.591987        0.0000000
                   A12          5.591987        0.0000000
                   A14          5.589100        0.0000000
                   A16          5.033430        0.0000000
                   A18          3.361394        0.0000000
                   A20          1.686471        0.0000000
                   A46          0.4000000       30.00000
                   A48          0.4000000       30.00000
                   A51          0.4000000       30.00000
                   A54          0.4642299       0.0000000
                   A57          1.019899        0.0000000
                   A60          1.019899        0.0000000
                   A63          0.4642299       0.0000000
                   A66          0.4000000       30.00000
                   A69          0.4000000       30.00000
                   A71          0.4000000       30.00000
                   A44          1.183684        0.0000000
                    A7          1.177584        0.0000000
                   A49          0.3913477       0.0000000
                   A52          0.2300000       28.87000
                   A55          0.2300000       28.87000
                   A58          0.2300000       28.87000
                   A61          0.3913477       0.0000000
                   A64          1.177584        0.0000000
                   A67          1.183684        0.0000000
                    N1          78911.66        0.0000000
                    N2         -109523.5        0.0000000
                    N3          157283.0        0.0000000
                    N4         -187.4820        0.0000000
                   N25         -108961.0        0.0000000
                   N44          75683.57        0.0000000
                    N5          235519.2        0.0000000
                    N6         -108586.1        0.0000000
                   N26          0.0000000       0.0000000
                    N7          75293.57        0.0000000
                    N8          261519.6        0.0000000
                    N9          0.0000000       0.0000000
                   N29         -36086.50        0.0000000
                   N49          25022.38        0.0000000
                   N10          261654.6        0.0000000
                   N11         -187.4820        0.0000000
                   N30          0.0000000       0.0000000
                   N52          130.0000        0.0000000
                   N12          261654.6        0.0000000
                   N13          0.0000000       0.0000000
                   N33          0.0000000       0.0000000
                   N55          0.0000000       0.0000000
                   N14          261519.6        0.0000000
                   N15          0.0000000       0.0000000
```

N34	-187.4820	0.0000000
N58	130.0000	0.0000000
N16	235519.2	0.0000000
N17	-36086.50	0.0000000
N37	0.0000000	0.0000000
N61	25022.38	0.0000000
N18	157283.0	0.0000000
N19	0.0000000	0.0000000
N38	-108586.1	0.0000000
N64	75293.57	0.0000000
N20	78911.66	0.0000000
N21	-108961.0	0.0000000
N41	-187.4820	0.0000000
N67	75683.57	0.0000000
N42	-109523.5	0.0000000
N23	-187.4820	0.0000000
N24	-109523.5	0.0000000
N45	0.0000000	-0.1088121E-02
N47	-108961.0	0.0000000
N27	0.0000000	-0.1088121E-02
N28	-108586.1	0.0000000
N50	0.0000000	-0.3130868E-03
N53	-36086.50	0.0000000
N31	0.0000000	0.0000000
N32	-187.4820	0.0000000
N56	-187.4820	0.0000000
N59	0.0000000	0.0000000
N35	-36086.50	0.0000000
N36	0.0000000	-0.3130868E-03
N62	-108586.1	0.0000000
N65	0.0000000	-0.1088121E-02
N39	-108961.0	0.0000000
N40	0.0000000	-0.1088121E-02
N68	-109523.5	0.0000000
N70	-187.4820	0.0000000
N46	135.0808	0.0000000
N43	0.0000000	0.1117731E-02
N48	-78776.58	0.0000000
N51	-157283.0	0.0000000
N54	-235519.2	0.0000000
N57	-261519.6	0.0000000
N60	-261519.6	0.0000000
N63	-235519.2	0.0000000
N66	-157283.0	0.0000000
N69	-78776.58	0.0000000
N71	135.0808	0.0000000
N22	0.0000000	0.1117731E-02

→ **EXEMPLO 2 - PELA NOVA NORMA**

- **Dimensionamento para P = 89 kN:**

```
model:

DATA:
P = 63560;
ENDDATA

 min = (A1 * 30 + A3 * 30 + A5 * 30 + A8 * 30 + A10 * 30 + A12 *
30 + A14 * 30 + A16 * 30 + A18 * 30 + A20 * 30 + A46 * 30 + A48 *
30 + A51 * 30 + A54 * 30 + A57 * 30 + A60 * 30 + A63 * 30 + A66 *
30 + A69 * 30 + A71 * 30 + A44 * 28.87 + A7 * 28.87 + A49 * 28.87
+ A52 * 28.87 + A55 * 28.87 + A58 * 28.87 + A61 * 28.87 + A64 *
28.87 + A67 * 28.87 );

+ 1.0000 * N1 + 0.7205 * N2 = 0;
- 1.0000 * N1 + 1.0000 * N3 - 0.7205 * N4 + 0.7205 * N25 = 0 ;
+ 0.6934 * N4 + 0.6934 * N25 + 1.0000 * N44 = 0 ;
- 1.0000 * N3 + 1.0000 * N5 + 0.7205 * N6 - 0.7205 * N26 = 0 ;
+ 0.6934 * N6 + 1.0000 * N7 + 0.6934 * N26 = 0 ;
- 1.0000 * N5 + 1.0000 * N8 - 0.7205 * N9 + 0.7205 * N29 = 0 ;
+ 0.6934 * N9 + 0.6934 * N29 + 1.0000 * N49 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7205 * N11 - 0.7205 * N30 = 0 ;
+ 0.6934 * N11 + 0.6934 * N30 + 1.0000 * N52 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7205 * N13 + 0.7205 * N33 = 0 ;
+ 0.6934 * N13 + 0.6934 * N33 + 1.0000 * N55 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7205 * N15 - 0.7205 * N34 = 0 ;
+ 0.6934 * N15 + 0.6934 * N34 + 1.0000 * N58 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7205 * N17 + 0.7205 * N37 = 0 ;
+ 0.6934 * N17 + 0.6934 * N37 + 1.0000 * N61 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7205 * N19 - 0.7205 * N38 = 0 ;
+ 0.6934 * N19 + 0.6934 * N38 + 1.0000 * N64 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7205 * N21 + 0.7205 * N41 = 0 ;
+ 0.6934 * N21 + 0.6934 * N41 + 1.0000 * N67 = 0 ;
- 1.0000 * N20 - 0.7205 * N42 = 0;
- 0.7205 * N2 + 0.7205 * N4 - 0.7205 * N23 + 0.7205 * N24 = 0 ;
- 0.6934 * N2 - 0.6934 * N4 + 0.6934 * N23 + 0.6934 * N24 = 0 ;
- 0.7205 * N25 + 0.7205 * N26 - 0.7205 * N45 + 0.7205 * N47 = 0 ;
- 0.6934 * N25 - 0.6934 * N26 + 0.6934 * N45 + 0.6934 * N47 = 0 ;
- 0.7205 * N6 + 0.7205 * N9 - 0.7205 * N27 + 0.7205 * N28 = 0 ;
- 0.6934 * N6 - 0.6934 * N9 + 0.6934 * N27 + 0.6934 * N28 = 0 ;
- 0.7205 * N29 + 0.7205 * N30 - 0.7205 * N50 + 0.7205 * N53 = 0 ;
- 0.6934 * N29 - 0.6934 * N30 + 0.6934 * N50 + 0.6934 * N53 = 0 ;
- 0.7205 * N11 + 0.7205 * N13 - 0.7205 * N31 + 0.7205 * N32 = 0 ;
- 0.6934 * N11 - 0.6934 * N13 + 0.6934 * N31 + 0.6934 * N32 = 0 ;
- 0.7205 * N33 + 0.7205 * N34 - 0.7205 * N56 + 0.7205 * N59 = 0 ;
- 0.6934 * N33 - 0.6934 * N34 + 0.6934 * N56 + 0.6934 * N59 = 0 ;
- 0.7205 * N15 + 0.7205 * N17 - 0.7205 * N35 + 0.7205 * N36 = 0 ;
- 0.6934 * N15 - 0.6934 * N17 + 0.6934 * N35 + 0.6934 * N36 = 0 ;
- 0.7205 * N37 + 0.7205 * N38 - 0.7205 * N62 + 0.7205 * N65 = 0 ;
- 0.6934 * N37 - 0.6934 * N38 + 0.6934 * N62 + 0.6934 * N65 = 0 ;
- 0.7205 * N19 + 0.7205 * N21 - 0.7205 * N39 + 0.7205 * N40 = 0 ;
- 0.6934 * N19 - 0.6934 * N21 + 0.6934 * N39 + 0.6934 * N40 = 0 ;
- 0.7205 * N41 + 0.7205 * N42 - 0.7205 * N68 + 0.7205 * N70 = 0 ;
- 0.6934 * N41 - 0.6934 * N42 + 0.6934 * N68 + 0.6934 * N70 = 0 ;
```

```
+ 0.7205 * N23 + 1.0000 * N46 = 0 ;
- 130 - 0.6934 * N23 - 1.0000 * N43 = 0 ;
- 0.7205 * N24 + 0.7205 * N45 - 1.0000 * N46 + 1.0000 * N48 = 0 ;
- 260 - 0.6934 * N24 - 1.0000 * N44 - 0.6934 * N45 = 0 ;
+ 0.7205 * N27 - 0.7205 * N47 - 1.0000 * N48 + 1.0000 * N51 = 0 ;
- 260 - 1.0000 * N7 - 0.6934 * N27 - 0.6934 * N47 = 0 ;
- 0.7205 * N28 + 0.7205 * N50 - 1.0000 * N51 + 1.0000 * N54 = 0 ;
- 0.67 * P - 260 - 0.6934 * N28 - 1.0000 * N49 - 0.6934 * N50 = 0;
+ 0.7205 * N31 - 0.7205 * N53 - 1.0000 * N54 + 1.0000 * N57 = 0 ;
- 0.33 * P - 260 - 0.6934 * N31 - 1.0000 * N52 - 0.6934 * N53 = 0;
- 0.7205 * N32 + 0.7205 * N56 - 1.0000 * N57 + 1.0000 * N60 = 0 ;
- 260 - 0.6934 * N32 - 1.0000 * N55 - 0.6934 * N56 = 0 ;
+ 0.7205 * N35 - 0.7205 * N59 - 1.0000 * N60 + 1.0000 * N63 = 0 ;
- 0.33 * P - 260 - 0.6934 * N35 - 1.0000 * N58 - 0.6934 * N59 = 0;
- 0.7205 * N36 + 0.7205 * N62 - 1.0000 * N63 + 1.0000 * N66 = 0 ;
- 0.67 * P - 260 - 0.6934 * N36 - 1.0000 * N61 - 0.6934 * N62 = 0;
+ 0.7205 * N39 - 0.7205 * N65 - 1.0000 * N66 + 1.0000 * N69 = 0 ;
- 260 - 0.6934 * N39 - 1.0000 * N64 - 0.6934 * N65 = 0 ;
- 0.7205 * N40 + 0.7205 * N68 - 1.0000 * N69 + 1.0000 * N71 = 0 ;
- 260 - 0.6934 * N40 - 1.0000 * N67 - 0.6934 * N68 = 0 ;
- 0.7205 * N70 - 1.0000 * N71 = 0 ;
- 130 - 1.0000 * N22 - 0.6934 * N70 = 0 ;
N1 - 46791 * A1 <= 0;
213797.46 + 46791 * A1 + N1 >= 0;
N3 - 46791 * A3 <= 0;
213797.46 + 46791 * A3 + N3 >= 0;
N5 - 46791 * A5 <= 0;
213797.46 + 46791 * A5 + N5 >= 0;
N8 - 46791 * A8 <= 0;
213797.46 + 46791 * A8 + N8 >= 0;
N10 - 46791 * A10 <= 0;
213797.46 + 46791 * A10 + N10 >= 0;
N12 - 46791 * A12 <= 0;
213797.46 + 46791 * A12 + N12 >= 0;
N14 - 46791 * A14 <= 0;
213797.46 + 46791 * A14 + N14 >= 0;
N16 - 46791 * A16 <= 0;
213797.46 + 46791 * A16 + N16 >= 0;
N18 - 46791 * A18 <= 0;
213797.46 + 46791 * A18 + N18 >= 0;
N20 - 46791 * A20 <= 0;
213797.46 + 46791 * A20 + N20 >= 0;
N46 - 46791 * 46 <= 0;
213797.46 + 46791 * A46 + N46 >= 0;
N48 - 46791 * A48 <= 0;
213797.46 + 46791 * A48 + N48 >= 0;
N51 - 46791 * A51 <= 0;
213797.46 + 46791 * A51 + N51 >= 0;
N54 - 46791 * A54 <= 0;
213797.46 + 46791 * A54 + N54 >= 0;
N57 - 46791 * A57 <= 0;
213797.46 + 46791 * A57 + N57 >= 0;
N60 - 46791 * A60 <= 0;
213797.46 + 46791 * A60 + N60 >= 0;
N63 - 46791 * A63 <= 0;
213797.46 + 46791 * A63 + N63 >= 0;
N66 - 46791 * A66 <= 0;
213797.46 + 46791 * A66 + N66 >= 0;
N69 - 46791 * A69 <= 0;
213797.46 + 46791 * A69 + N69 >= 0;
N71 - 46791 * A71 <= 0;
```

```
213797.46 + 46791 * A71 + N71 >= 0;
N44 - 63939 * A44 <= 0;
N7 - 63939 * A7 <= 0;
N49 - 63939 * A49 <= 0;
N52 - 63939 * A52 <= 0;
N55 - 63939 * A55 <= 0;
N58 - 63939 * A58 <= 0;
N61 - 63939 * A61 <= 0;
N64 - 63939 * A64 <= 0;
N67 - 63939 * A67 <= 0;


@BND(-708275.5059,N1,408956.0000);
@BND(-209344.1819,N2,0.0000);
@BND(-708275.5059,N3,408956.0000);
@BND(-209344.1819,N4,0.0000);
@BND(-708275.5059,N5,408956.0000);
@BND(-209344.1819,N6,0.0000);
@BND(0.0000,N7,108960.8400);
@BND(-708275.5059,N8,408956.0000);
@BND(-209344.1819,N9,0.0000);
@BND(-708275.5059,N10,408956.0000);
@BND(-209344.1819,N11,0.0000);
@BND(-708275.5059,N12,408956.0000);
@BND(-209344.1819,N13,0.0000);
@BND(-708275.5059,N14,408956.0000);
@BND(-209344.1819,N15,0.0000);
@BND(-708275.5059,N16,408956.0000);
@BND(-209344.1819,N17,0.0000);
@BND(-708275.5059,N18,408956.0000);
@BND(-209344.1819,N19,0.0000);
@BND(-708275.5059,N20,408956.0000);
@BND(-209344.1819,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-209344.1819,N23,0.0000);
@BND(-209344.1819,N24,0.0000);
@BND(-209344.1819,N25,0.0000);
@BND(-209344.1819,N26,0.0000);
@BND(-209344.1819,N27,0.0000);
@BND(-209344.1819,N28,0.0000);
@BND(-209344.1819,N29,0.0000);
@BND(-209344.1819,N30,0.0000);
@BND(-209344.1819,N31,0.0000);
@BND(-209344.1819,N32,0.0000);
@BND(-209344.1819,N33,0.0000);
@BND(-209344.1819,N34,0.0000);
@BND(-209344.1819,N35,0.0000);
@BND(-209344.1819,N36,0.0000);
@BND(-209344.1819,N37,0.0000);
@BND(-209344.1819,N38,0.0000);
@BND(-209344.1819,N39,0.0000);
@BND(-209344.1819,N40,0.0000);
@BND(-209344.1819,N41,0.0000);
@BND(-209344.1819,N42,0.0000);
@BND(0.0000,N43,0.0000);
@BND(0.0000,N44,108960.8400);
@BND(-209344.1819,N45,0.0000);
@BND(-320843.5059,N46,21524.0000);
@BND(-209344.1819,N47,0.0000);
@BND(-320843.5059,N48,21524.0000);
@BND(0.0000,N49,108960.8400);
@BND(-209344.1819,N50,0.0000);
```

```
@BND(-320843.5059,N51,21524.0000);
@BND(0.0000,N52,108960.8400);
@BND(-209344.1819,N53,0.0000);
@BND(-320843.5059,N54,21524.0000);
@BND(0.0000,N55,108960.8400);
@BND(-209344.1819,N56,0.0000);
@BND(-320843.5059,N57,21524.0000);
@BND(0.0000,N58,108960.8400);
@BND(-209344.1819,N59,0.0000);
@BND(-320843.5059,N60,21524.0000);
@BND(0.0000,N61,108960.8400);
@BND(-209344.1819,N62,0.0000);
@BND(-320843.5059,N63,21524.0000);
@BND(0.0000,N64,108960.8400);
@BND(-209344.1819,N65,0.0000);
@BND(-320843.5059,N66,21524.0000);
@BND(0.0000,N67,108960.8400);
@BND(-209344.1819,N68,0.0000);
@BND(-320843.5059,N69,21524.0000);
@BND(-209344.1819,N70,0.0000);
@BND(-320843.5059,N71,21524.0000);
@BND(0.72,A1,19.2);
@BND(0.72,A3,19.2);
@BND(0.72,A5,19.2);
@BND(0.72,A8,19.2);
@BND(0.72,A10,19.2);
@BND(0.72,A12,19.2);
@BND(0.72,A14,19.2);
@BND(0.72,A16,19.2);
@BND(0.72,A18,19.2);
@BND(0.72,A20,19.2);
@BND(0.4,A46,19.2);
@BND(0.4,A48,19.2);
@BND(0.4,A51,19.2);
@BND(0.4,A54,19.2);
@BND(0.4,A57,19.2);
@BND(0.4,A60,19.2);
@BND(0.4,A63,19.2);
@BND(0.4,A66,19.2);
@BND(0.4,A69,19.2);
@BND(0.4,A71,19.2);
@BND(0.23,A44,14.4);
@BND(0.23,A7,14.4);
@BND(0.23,A49,14.4);
@BND(0.23,A52,14.4);
@BND(0.23,A55,14.4);
@BND(0.23,A58,14.4);
@BND(0.23,A61,14.4);
@BND(0.23,A64,14.4);
@BND(0.23,A67,14.4);


@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N70);
@FREE(N71);

END
```

- **Resultado do Dimensionamento para P = 89 kN:**

```
Global optimal solution found at step:              72
 Objective value:                              1364.317

                    Variable           Value          Reduced Cost
                        P          63560.00           0.0000000
                       A1          1.440339           0.0000000
                       A3          2.869131           0.0000000
                       A5          4.295035           0.0000000
                       A8          4.769481           0.0000000
                      A10          4.772368           0.0000000
                      A12          4.772368           0.0000000
                      A14          4.769481           0.0000000
                      A16          4.295035           0.0000000
                      A18          2.869131           0.0000000
                      A20          1.440339           0.0000000
                      A46         0.4000000            30.00000
                      A48         0.4000000            30.00000
                      A51         0.4000000            30.00000
                      A54         0.4000000            30.00000
                      A57         0.4000000            30.00000
                      A60         0.4000000            30.00000
                      A63         0.4000000            30.00000
                      A66         0.4000000            30.00000
                      A69         0.4000000            30.00000
                      A71         0.4000000            30.00000
                      A44          1.010338           0.0000000
                       A7          1.004238           0.0000000
                      A49         0.3341435           0.0000000
                      A52         0.2300000            28.87000
                      A55         0.2300000            28.87000
                      A58         0.2300000            28.87000
                      A61         0.3341435           0.0000000
                      A64          1.004238           0.0000000
                      A67          1.010338           0.0000000
                       N1          67394.91           0.0000000
                       N2         -93539.08           0.0000000
                       N3          134249.5           0.0000000
                       N4         -187.4820           0.0000000
                      N25         -92976.64           0.0000000
                      N44          64600.00           0.0000000
                       N5          200969.0           0.0000000
                       N6         -92601.67           0.0000000
                      N26         0.0000000           0.0000000
                       N7          64210.00           0.0000000
                       N8          223168.8           0.0000000
                       N9         0.0000000           0.0000000
                      N29         -30811.65           0.0000000
                      N49          21364.80           0.0000000
                      N10          223303.9           0.0000000
                      N11         -187.4820           0.0000000
                      N30         0.0000000           0.0000000
                      N52          130.0000           0.0000000
                      N12          223303.9           0.0000000
                      N13         0.0000000           0.0000000
                      N33         0.0000000           0.0000000
                      N55         0.0000000           0.0000000
                      N14          223168.8           0.0000000
                      N15         0.0000000           0.0000000
```

```
N34          -187.4820            0.0000000
N58           130.0000            0.0000000
N16           200969.0            0.0000000
N17          -30811.65            0.0000000
N37          0.0000000            0.0000000
N61           21364.80            0.0000000
N18           134249.5            0.0000000
N19          0.0000000            0.0000000
N38          -92601.67            0.0000000
N64           64210.00            0.0000000
N20           67394.91            0.0000000
N21          -92976.64            0.0000000
N41          -187.4820            0.0000000
N67           64600.00            0.0000000
N42          -93539.08            0.0000000
N23          -187.4820            0.0000000
N24          -93539.08            0.0000000
N45          0.0000000           -0.1088121E-02
N47          -92976.64            0.0000000
N27          0.0000000           -0.1088121E-02
N28          -92601.67            0.0000000
N50          0.0000000           -0.7750346E-03
N53          -30811.65            0.0000000
N31          0.0000000           -0.4619478E-03
N32          -187.4820            0.0000000
N56          -187.4820            0.0000000
N59          0.0000000           -0.4619478E-03
N35          -30811.65            0.0000000
N36          0.0000000           -0.7750346E-03
N62          -92601.67            0.0000000
N65          0.0000000           -0.1088121E-02
N39          -92976.64            0.0000000
N40          0.0000000           -0.1088121E-02
N68          -93539.08            0.0000000
N70          -187.4820            0.0000000
N46           135.0808            0.0000000
N43          0.0000000            0.1117731E-02
N48          -67259.83            0.0000000
N51          -134249.5            0.0000000
N54          -200969.0            0.0000000
N57          -223168.8            0.0000000
N60          -223168.8            0.0000000
N63          -200969.0            0.0000000
N66          -134249.5            0.0000000
N69          -67259.83            0.0000000
N71           135.0808            0.0000000
N22          0.0000000            0.1117731E-02
```

- **Dimensionamento pa ra P = 104,5 kN:**

```
model:

DATA:
P = 74643.57;
ENDDATA

 min = (A1 * 30 + A3 * 30 + A5 * 30 + A8 * 30 + A10 * 30 + A12 *
30 + A14 * 30 + A16 * 30 + A18 * 30 + A20 * 30 + A46 * 30 + A48 *
30 + A51 * 30 + A54 * 30 + A57 * 30 + A60 * 30 + A63 * 30 + A66 *
30 + A69 * 30 + A71 * 30 + A44 * 28.87 + A7 * 28.87 + A49 * 28.87
+ A52 * 28.87 + A55 * 28.87 + A58 * 28.87 + A61 * 28.87 + A64 *
28.87 + A67 * 28.87 );

+ 1.0000 * N1 + 0.7205 * N2 = 0;
- 1.0000 * N1 + 1.0000 * N3 - 0.7205 * N4 + 0.7205 * N25 = 0 ;
+ 0.6934 * N4 + 0.6934 * N25 + 1.0000 * N44 = 0 ;
- 1.0000 * N3 + 1.0000 * N5 + 0.7205 * N6 - 0.7205 * N26 = 0 ;
+ 0.6934 * N6 + 1.0000 * N7 + 0.6934 * N26 = 0 ;
- 1.0000 * N5 + 1.0000 * N8 - 0.7205 * N9 + 0.7205 * N29 = 0 ;
+ 0.6934 * N9 + 0.6934 * N29 + 1.0000 * N49 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7205 * N11 - 0.7205 * N30 = 0 ;
+ 0.6934 * N11 + 0.6934 * N30 + 1.0000 * N52 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7205 * N13 + 0.7205 * N33 = 0 ;
+ 0.6934 * N13 + 0.6934 * N33 + 1.0000 * N55 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7205 * N15 - 0.7205 * N34 = 0 ;
+ 0.6934 * N15 + 0.6934 * N34 + 1.0000 * N58 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7205 * N17 + 0.7205 * N37 = 0 ;
+ 0.6934 * N17 + 0.6934 * N37 + 1.0000 * N61 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7205 * N19 - 0.7205 * N38 = 0 ;
+ 0.6934 * N19 + 0.6934 * N38 + 1.0000 * N64 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7205 * N21 + 0.7205 * N41 = 0 ;
+ 0.6934 * N21 + 0.6934 * N41 + 1.0000 * N67 = 0 ;
- 1.0000 * N20 - 0.7205 * N42 = 0;
- 0.7205 * N2 + 0.7205 * N4 - 0.7205 * N23 + 0.7205 * N24 = 0 ;
- 0.6934 * N2 - 0.6934 * N4 + 0.6934 * N23 + 0.6934 * N24 = 0 ;
- 0.7205 * N25 + 0.7205 * N26 - 0.7205 * N45 + 0.7205 * N47 = 0 ;
- 0.6934 * N25 - 0.6934 * N26 + 0.6934 * N45 + 0.6934 * N47 = 0 ;
- 0.7205 * N6 + 0.7205 * N9 - 0.7205 * N27 + 0.7205 * N28 = 0 ;
- 0.6934 * N6 - 0.6934 * N9 + 0.6934 * N27 + 0.6934 * N28 = 0 ;
- 0.7205 * N29 + 0.7205 * N30 - 0.7205 * N50 + 0.7205 * N53 = 0 ;
- 0.6934 * N29 - 0.6934 * N30 + 0.6934 * N50 + 0.6934 * N53 = 0 ;
- 0.7205 * N11 + 0.7205 * N13 - 0.7205 * N31 + 0.7205 * N32 = 0 ;
- 0.6934 * N11 - 0.6934 * N13 + 0.6934 * N31 + 0.6934 * N32 = 0 ;
- 0.7205 * N33 + 0.7205 * N34 - 0.7205 * N56 + 0.7205 * N59 = 0 ;
- 0.6934 * N33 - 0.6934 * N34 + 0.6934 * N56 + 0.6934 * N59 = 0 ;
- 0.7205 * N15 + 0.7205 * N17 - 0.7205 * N35 + 0.7205 * N36 = 0 ;
- 0.6934 * N15 - 0.6934 * N17 + 0.6934 * N35 + 0.6934 * N36 = 0 ;
- 0.7205 * N37 + 0.7205 * N38 - 0.7205 * N62 + 0.7205 * N65 = 0 ;
- 0.6934 * N37 - 0.6934 * N38 + 0.6934 * N62 + 0.6934 * N65 = 0 ;
- 0.7205 * N19 + 0.7205 * N21 - 0.7205 * N39 + 0.7205 * N40 = 0 ;
- 0.6934 * N19 - 0.6934 * N21 + 0.6934 * N39 + 0.6934 * N40 = 0 ;
- 0.7205 * N41 + 0.7205 * N42 - 0.7205 * N68 + 0.7205 * N70 = 0 ;
- 0.6934 * N41 - 0.6934 * N42 + 0.6934 * N68 + 0.6934 * N70 = 0 ;
+ 0.7205 * N23 + 1.0000 * N46 = 0 ;
- 130 - 0.6934 * N23 - 1.0000 * N43 = 0 ;
- 0.7205 * N24 + 0.7205 * N45 - 1.0000 * N46 + 1.0000 * N48 = 0 ;
- 260 - 0.6934 * N24 - 1.0000 * N44 - 0.6934 * N45 = 0 ;
+ 0.7205 * N27 - 0.7205 * N47 - 1.0000 * N48 + 1.0000 * N51 = 0 ;
```

```
- 260 - 1.0000 * N7 - 0.6934 * N27 - 0.6934 * N47 = 0 ;
- 0.7205 * N28 + 0.7205 * N50 - 1.0000 * N51 + 1.0000 * N54 = 0 ;
- 0.67 * P - 260 - 0.6934 * N28 - 1.0000 * N49 - 0.6934 * N50 = 0;
+ 0.7205 * N31 - 0.7205 * N53 - 1.0000 * N54 + 1.0000 * N57 = 0 ;
- 0.33 * P - 260 - 0.6934 * N31 - 1.0000 * N52 - 0.6934 * N53 = 0;
- 0.7205 * N32 + 0.7205 * N56 - 1.0000 * N57 + 1.0000 * N60 = 0 ;
- 260 - 0.6934 * N32 - 1.0000 * N55 - 0.6934 * N56 = 0 ;
+ 0.7205 * N35 - 0.7205 * N59 - 1.0000 * N60 + 1.0000 * N63 = 0 ;
- 0.33 * P - 260 - 0.6934 * N35 - 1.0000 * N58 - 0.6934 * N59 = 0;
- 0.7205 * N36 + 0.7205 * N62 - 1.0000 * N63 + 1.0000 * N66 = 0 ;
- 0.67 * P - 260 - 0.6934 * N36 - 1.0000 * N61 - 0.6934 * N62 = 0;
+ 0.7205 * N39 - 0.7205 * N65 - 1.0000 * N66 + 1.0000 * N69 = 0 ;
- 260 - 0.6934 * N39 - 1.0000 * N64 - 0.6934 * N65 = 0 ;
- 0.7205 * N40 + 0.7205 * N68 - 1.0000 * N69 + 1.0000 * N71 = 0 ;
- 260 - 0.6934 * N40 - 1.0000 * N67 - 0.6934 * N68 = 0 ;
- 0.7205 * N70 - 1.0000 * N71 = 0 ;
- 130 - 1.0000 * N22 - 0.6934 * N70 = 0 ;
N1 - 46791 * A1 <= 0;
213797.46 + 46791 * A1 + N1 >= 0;
N3 - 46791 * A3 <= 0;
213797.46 + 46791 * A3 + N3 >= 0;
N5 - 46791 * A5 <= 0;
213797.46 + 46791 * A5 + N5 >= 0;
N8 - 46791 * A8 <= 0;
213797.46 + 46791 * A8 + N8 >= 0;
N10 - 46791 * A10 <= 0;
213797.46 + 46791 * A10 + N10 >= 0;
N12 - 46791 * A12 <= 0;
213797.46 + 46791 * A12 + N12 >= 0;
N14 - 46791 * A14 <= 0;
213797.46 + 46791 * A14 + N14 >= 0;
N16 - 46791 * A16 <= 0;
213797.46 + 46791 * A16 + N16 >= 0;
N18 - 46791 * A18 <= 0;
213797.46 + 46791 * A18 + N18 >= 0;
N20 - 46791 * A20 <= 0;
213797.46 + 46791 * A20 + N20 >= 0;
N46 - 46791 * 46 <= 0;
213797.46 + 46791 * A46 + N46 >= 0;
N48 - 46791 * A48 <= 0;
213797.46 + 46791 * A48 + N48 >= 0;
N51 - 46791 * A51 <= 0;
213797.46 + 46791 * A51 + N51 >= 0;
N54 - 46791 * A54 <= 0;
213797.46 + 46791 * A54 + N54 >= 0;
N57 - 46791 * A57 <= 0;
213797.46 + 46791 * A57 + N57 >= 0;
N60 - 46791 * A60 <= 0;
213797.46 + 46791 * A60 + N60 >= 0;
N63 - 46791 * A63 <= 0;
213797.46 + 46791 * A63 + N63 >= 0;
N66 - 46791 * A66 <= 0;
213797.46 + 46791 * A66 + N66 >= 0;
N69 - 46791 * A69 <= 0;
213797.46 + 46791 * A69 + N69 >= 0;
N71 - 46791 * A71 <= 0;
213797.46 + 46791 * A71 + N71 >= 0;
N44 - 63939 * A44 <= 0;
N7 - 63939 * A7 <= 0;
N49 - 63939 * A49 <= 0;
N52 - 63939 * A52 <= 0;
```

```
N55 - 63939 * A55 <= 0;
N58 - 63939 * A58 <= 0;
N61 - 63939 * A61 <= 0;
N64 - 63939 * A64 <= 0;
N67 - 63939 * A67 <= 0;

@BND(-708275.5059,N1,408956.0000);
@BND(-209344.1819,N2,0.0000);
@BND(-708275.5059,N3,408956.0000);
@BND(-209344.1819,N4,0.0000);
@BND(-708275.5059,N5,408956.0000);
@BND(-209344.1819,N6,0.0000);
@BND(0.0000,N7,108960.8400);
@BND(-708275.5059,N8,408956.0000);
@BND(-209344.1819,N9,0.0000);
@BND(-708275.5059,N10,408956.0000);
@BND(-209344.1819,N11,0.0000);
@BND(-708275.5059,N12,408956.0000);
@BND(-209344.1819,N13,0.0000);
@BND(-708275.5059,N14,408956.0000);
@BND(-209344.1819,N15,0.0000);
@BND(-708275.5059,N16,408956.0000);
@BND(-209344.1819,N17,0.0000);
@BND(-708275.5059,N18,408956.0000);
@BND(-209344.1819,N19,0.0000);
@BND(-708275.5059,N20,408956.0000);
@BND(-209344.1819,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-209344.1819,N23,0.0000);
@BND(-209344.1819,N24,0.0000);
@BND(-209344.1819,N25,0.0000);
@BND(-209344.1819,N26,0.0000);
@BND(-209344.1819,N27,0.0000);
@BND(-209344.1819,N28,0.0000);
@BND(-209344.1819,N29,0.0000);
@BND(-209344.1819,N30,0.0000);
@BND(-209344.1819,N31,0.0000);
@BND(-209344.1819,N32,0.0000);
@BND(-209344.1819,N33,0.0000);
@BND(-209344.1819,N34,0.0000);
@BND(-209344.1819,N35,0.0000);
@BND(-209344.1819,N36,0.0000);
@BND(-209344.1819,N37,0.0000);
@BND(-209344.1819,N38,0.0000);
@BND(-209344.1819,N39,0.0000);
@BND(-209344.1819,N40,0.0000);
@BND(-209344.1819,N41,0.0000);
@BND(-209344.1819,N42,0.0000);
@BND(0.0000,N43,0.0000);
@BND(0.0000,N44,108960.8400);
@BND(-209344.1819,N45,0.0000);
@BND(-320843.5059,N46,21524.0000);
@BND(-209344.1819,N47,0.0000);
@BND(-320843.5059,N48,21524.0000);
@BND(0.0000,N49,108960.8400);
@BND(-209344.1819,N50,0.0000);
@BND(-320843.5059,N51,21524.0000);
@BND(0.0000,N52,108960.8400);
@BND(-209344.1819,N53,0.0000);
@BND(-320843.5059,N54,21524.0000);
@BND(0.0000,N55,108960.8400);
```

```
@BND(-209344.1819,N56,0.0000);
@BND(-320843.5059,N57,21524.0000);
@BND(0.0000,N58,108960.8400);
@BND(-209344.1819,N59,0.0000);
@BND(-320843.5059,N60,21524.0000);
@BND(0.0000,N61,108960.8400);
@BND(-209344.1819,N62,0.0000);
@BND(-320843.5059,N63,21524.0000);
@BND(0.0000,N64,108960.8400);
@BND(-209344.1819,N65,0.0000);
@BND(-320843.5059,N66,21524.0000);
@BND(0.0000,N67,108960.8400);
@BND(-209344.1819,N68,0.0000);
@BND(-320843.5059,N69,21524.0000);
@BND(-209344.1819,N70,0.0000);
@BND(-320843.5059,N71,21524.0000);
@BND(0.72,A1,19.2);
@BND(0.72,A3,19.2);
@BND(0.72,A5,19.2);
@BND(0.72,A8,19.2);
@BND(0.72,A10,19.2);
@BND(0.72,A12,19.2);
@BND(0.72,A14,19.2);
@BND(0.72,A16,19.2);
@BND(0.72,A18,19.2);
@BND(0.72,A20,19.2);
@BND(0.4,A46,19.2);
@BND(0.4,A48,19.2);
@BND(0.4,A51,19.2);
@BND(0.4,A54,19.2);
@BND(0.4,A57,19.2);
@BND(0.4,A60,19.2);
@BND(0.4,A63,19.2);
@BND(0.4,A66,19.2);
@BND(0.4,A69,19.2);
@BND(0.4,A71,19.2);
@BND(0.23,A44,14.4);
@BND(0.23,A7,14.4);
@BND(0.23,A49,14.4);
@BND(0.23,A52,14.4);
@BND(0.23,A55,14.4);
@BND(0.23,A58,14.4);
@BND(0.23,A61,14.4);
@BND(0.23,A64,14.4);
@BND(0.23,A67,14.4);


@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N70);
@FREE(N71);

END
```

- **Resultado do Dimensionamento para P = 104,5 kN:**

```
Global optimal solution found at step:                    65
 Objective value:                                  1615.647

                Variable           Value       Reduced Cost
                       P         74643.57        0.0000000
                      A1         1.686471        0.0000000
                      A3         3.361394        0.0000000
                      A5         5.033430        0.0000000
                      A8         5.589100        0.0000000
                     A10         5.591987        0.0000000
                     A12         5.591987        0.0000000
                     A14         5.589100        0.0000000
                     A16         5.033430        0.0000000
                     A18         3.361394        0.0000000
                     A20         1.686471        0.0000000
                     A46        0.4000000         30.00000
                     A48        0.4000000         30.00000
                     A51        0.4000000         30.00000
                     A54        0.4642299        0.0000000
                     A57         1.019899        0.0000000
                     A60         1.019899        0.0000000
                     A63        0.4642299        0.0000000
                     A66        0.4000000         30.00000
                     A69        0.4000000         30.00000
                     A71        0.4000000         30.00000
                     A44         1.183684        0.0000000
                      A7         1.177584        0.0000000
                     A49        0.3913477        0.0000000
                     A52        0.2300000         28.87000
                     A55        0.2300000         28.87000
                     A58        0.2300000         28.87000
                     A61        0.3913477        0.0000000
                     A64         1.177584        0.0000000
                     A67         1.183684        0.0000000
                      N1         78911.66        0.0000000
                      N2        -109523.5        0.0000000
                      N3         157283.0        0.0000000
                      N4        -187.4820        0.0000000
                     N25        -108961.0        0.0000000
                     N44         75683.57        0.0000000
                      N5         235519.2        0.0000000
                      N6        -108586.1        0.0000000
                     N26        0.0000000        0.0000000
                      N7         75293.57        0.0000000
                      N8         261519.6        0.0000000
                      N9        0.0000000        0.0000000
                     N29        -36086.50        0.0000000
                     N49         25022.38        0.0000000
                     N10         261654.6        0.0000000
                     N11        -187.4820        0.0000000
                     N30        0.0000000        0.0000000
                     N52         130.0000        0.0000000
                     N12         261654.6        0.0000000
                     N13        0.0000000        0.0000000
                     N33        0.0000000        0.0000000
                     N55        0.0000000        0.0000000
                     N14         261519.6        0.0000000
                     N15        0.0000000      -0.3130868E-03
```

N34	-187.4820	0.0000000
N58	130.0000	0.0000000
N16	235519.2	0.0000000
N17	-36086.50	0.0000000
N37	0.0000000	-0.1088121E-02
N61	25022.38	0.0000000
N18	157283.0	0.0000000
N19	0.0000000	0.0000000
N38	-108586.1	0.0000000
N64	75293.57	0.0000000
N20	78911.66	0.0000000
N21	-108961.0	0.0000000
N41	-187.4820	0.0000000
N67	75683.57	0.0000000
N42	-109523.5	0.0000000
N23	-187.4820	0.0000000
N24	-109523.5	0.0000000
N45	0.0000000	-0.1088121E-02
N47	-108961.0	0.0000000
N27	0.0000000	-0.1088121E-02
N28	-108586.1	0.0000000
N50	0.0000000	-0.3130868E-03
N53	-36086.50	0.0000000
N31	0.0000000	0.0000000
N32	-187.4820	0.0000000
N56	-187.4820	0.0000000
N59	0.0000000	0.0000000
N35	-36086.50	0.0000000
N36	0.0000000	0.0000000
N62	-108586.1	0.0000000
N65	0.0000000	0.0000000
N39	-108961.0	0.0000000
N40	0.0000000	-0.1088121E-02
N68	-109523.5	0.0000000
N70	-187.4820	0.0000000
N46	135.0808	0.0000000
N43	0.0000000	0.1117731E-02
N48	-78776.58	0.0000000
N51	-157283.0	0.0000000
N54	-235519.2	0.0000000
N57	-261519.6	0.0000000
N60	-261519.6	0.0000000
N63	-235519.2	0.0000000
N66	-157283.0	0.0000000
N69	-78776.58	0.0000000
N71	135.0808	0.0000000
N22	0.0000000	0.1117731E-02

→ **EXEMPLO 3**

- **Carga de Colapso:**

```
model:

 max =P;
- 1.0000 * N1 + 1.0000 * N4 - 0.7066 * N5 + 0.7066 * N34 = 0 ;
+ 0.7076 * N5 + 0.7076 * N34 + 1.0000 * N61 = 0 ;
- 1.0000 * N4 + 1.0000 * N6 + 0.7066 * N7 - 0.7066 * N35 = 0 ;
+ 0.7076 * N7 + 0.7076 * N35 + 1.0000 * N64 = 0 ;
- 1.0000 * N6 + 1.0000 * N8 - 0.7066 * N9 + 0.7066 * N38 = 0 ;
+ 0.7076 * N9 + 0.7076 * N38 + 1.0000 * N67 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7066 * N11 - 0.7066 * N39 = 0 ;
+ 0.7076 * N11 + 0.7076 * N39 + 1.0000 * N70 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7066 * N13 + 0.7066 * N42 = 0 ;
+ 0.7076 * N13 + 0.7076 * N42 + 1.0000 * N73 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7066 * N15 - 0.7066 * N43 = 0 ;
+ 0.7076 * N15 + 0.7076 * N43 + 1.0000 * N76 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7066 * N17 + 0.7066 * N46 = 0 ;
+ 0.7076 * N17 + 0.7076 * N46 + 1.0000 * N79 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7066 * N19 - 0.7066 * N47 = 0 ;
+ 0.7076 * N19 + 0.7076 * N47 + 1.0000 * N82 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7066 * N21 + 0.7066 * N50 = 0 ;
+ 0.7076 * N21 + 0.7076 * N50 + 1.0000 * N84 = 0 ;
- 1.0000 * N20 + 1.0000 * N22 + 0.7066 * N23 - 0.7066 * N51 = 0 ;
+ 0.7076 * N23 + 0.7076 * N51 + 1.0000 * N87 = 0 ;
- 1.0000 * N22 + 1.0000 * N24 - 0.7066 * N25 + 0.7066 * N54 = 0 ;
+ 0.7076 * N25 + 1.0000 * N26 + 0.7076 * N54 = 0 ;
- 1.0000 * N24 + 1.0000 * N27 + 0.7066 * N28 - 0.7066 * N55 = 0 ;
+ 0.7076 * N28 + 0.7076 * N55 + 1.0000 * N93 = 0 ;
- 1.0000 * N27 + 1.0000 * N29 - 0.7066 * N30 + 0.7066 * N58 = 0 ;
+ 0.7076 * N30 + 0.7076 * N58 + 1.0000 * N95 = 0 ;
- 1.0000 * N29 - 0.7066 * N59 = 0 ;
- 0.7066 * N2 + 0.7066 * N5 - 0.7066 * N32 + 0.7066 * N33 = 0 ;
- 0.7076 * N2 - 0.7076 * N5 + 0.7076 * N32 + 0.7076 * N33 = 0 ;
- 0.7066 * N34 + 0.7066 * N35 - 0.7066 * N62 + 0.7066 * N65 = 0 ;
- 0.7076 * N34 - 0.7076 * N35 + 0.7076 * N62 + 0.7076 * N65 = 0 ;
- 0.7066 * N7 + 0.7066 * N9 - 0.7066 * N36 + 0.7066 * N37 = 0 ;
- 0.7076 * N7 - 0.7076 * N9 + 0.7076 * N36 + 0.7076 * N37 = 0 ;
- 0.7066 * N38 + 0.7066 * N39 - 0.7066 * N68 + 0.7066 * N71 = 0 ;
- 0.7076 * N38 - 0.7076 * N39 + 0.7076 * N68 + 0.7076 * N71 = 0 ;
- 0.7066 * N11 + 0.7066 * N13 - 0.7066 * N40 + 0.7066 * N41 = 0 ;
- 0.7076 * N11 - 0.7076 * N13 + 0.7076 * N40 + 0.7076 * N41 = 0 ;
- 0.7066 * N42 + 0.7066 * N43 - 0.7066 * N74 + 0.7066 * N77 = 0 ;
- 0.7076 * N42 - 0.7076 * N43 + 0.7076 * N74 + 0.7076 * N77 = 0 ;
- 0.7066 * N15 + 0.7066 * N17 - 0.7066 * N44 + 0.7066 * N45 = 0 ;
- 0.7076 * N15 - 0.7076 * N17 + 0.7076 * N44 + 0.7076 * N45 = 0 ;
- 0.7066 * N46 + 0.7066 * N47 - 0.7066 * N80 + 0.7066 * N83 = 0 ;
- 0.7076 * N46 - 0.7076 * N47 + 0.7076 * N80 + 0.7076 * N83 = 0 ;
- 0.7066 * N19 + 0.7066 * N21 - 0.7066 * N48 + 0.7066 * N49 = 0 ;
- 0.7076 * N19 - 0.7076 * N21 + 0.7076 * N48 + 0.7076 * N49 = 0 ;
- 0.7066 * N50 + 0.7066 * N51 - 0.7066 * N85 + 0.7066 * N88 = 0 ;
- 0.7076 * N50 - 0.7076 * N51 + 0.7076 * N85 + 0.7076 * N88 = 0 ;
- 0.7066 * N23 + 0.7066 * N25 - 0.7066 * N52 + 0.7066 * N53 = 0 ;
- 0.7076 * N23 - 0.7076 * N25 + 0.7076 * N52 + 0.7076 * N53 = 0 ;
- 0.7066 * N54 + 0.7066 * N55 - 0.7066 * N90 + 0.7066 * N94 = 0 ;
- 0.7076 * N54 - 0.7076 * N55 + 0.7076 * N90 + 0.7076 * N94 = 0 ;
```

```
- 0.7066 * N28 + 0.7066 * N30 - 0.7066 * N56 + 0.7066 * N57 = 0 ;
- 0.7076 * N28 - 0.7076 * N30 + 0.7076 * N56 + 0.7076 * N57 = 0 ;
- 0.7066 * N58 + 0.7066 * N59 - 0.7066 * N96 + 0.7066 * N98 = 0 ;
- 0.7076 * N58 - 0.7076 * N59 + 0.7076 * N96 + 0.7076 * N98 = 0 ;
- 0.7066 * N33 - 1.0000 * N60 + 0.7066 * N62 + 1.0000 * N63 = 0 ;
- 0.7076 * N33 - 1.0000 * N61 - 0.7076 * N62 = 0 ;
+ 0.7066 * N36 - 1.0000 * N63 - 0.7066 * N65 + 1.0000 * N66 = 0 ;
- 0.7076 * N36 - 1.0000 * N64 - 0.7076 * N65 = 0 ;
- 0.7066 * N37 - 1.0000 * N66 + 0.7066 * N68 + 1.0000 * N69 = 0 ;
- 0.7076 * N37 - 1.0000 * N67 - 0.7076 * N68 = 0 ;
+ 0.7066 * N40 - 1.0000 * N69 - 0.7066 * N71 + 1.0000 * N72 = 0 ;
- 0.7076 * N40 - 1.0000 * N70 - 0.7076 * N71 = 0 ;
- 0.7066 * N41 - 1.0000 * N72 + 0.7066 * N74 + 1.0000 * N75 = 0 ;
- 0.08 * P - 0.7076 * N41 - 1.0000 * N73 - 0.7076 * N74 = 0 ;
+ 0.7066 * N44 - 1.0000 * N75 - 0.7066 * N77 + 1.0000 * N78 = 0 ;
- 0.92 * P - 0.7076 * N44 - 1.0000 * N76 - 0.7076 * N77 = 0 ;
- 0.7066 * N45 - 1.0000 * N78 + 0.7066 * N80 + 1.0000 * N81 = 0 ;
- 0.7076 * N45 - 1.0000 * N79 - 0.7076 * N80 = 0 ;
+ 0.7066 * N48 - 1.0000 * N81 - 0.7066 * N83 + 1.0000 * N86 = 0 ;
- 0.7076 * N48 - 1.0000 * N82 - 0.7076 * N83 = 0 ;
- 0.7066 * N49 + 0.7066 * N85 - 1.0000 * N86 + 1.0000 * N89 = 0 ;
- 0.7076 * N49 - 1.0000 * N84 - 0.7076 * N85 = 0 ;
+ 0.7066 * N52 - 0.7066 * N88 - 1.0000 * N89 + 1.0000 * N91 = 0 ;
- 0.7076 * N52 - 1.0000 * N87 - 0.7076 * N88 = 0 ;
- 0.7066 * N53 + 0.7066 * N90 - 1.0000 * N91 + 1.0000 * N92 = 0 ;
- 1.0000 * N26 - 0.7076 * N53 - 0.7076 * N90 = 0 ;
+ 0.7066 * N56 - 1.0000 * N92 - 0.7066 * N94 + 1.0000 * N97 = 0 ;
- 0.7076 * N56 - 1.0000 * N93 - 0.7076 * N94 = 0 ;
- 0.7066 * N57 + 0.7066 * N96 - 1.0000 * N97 + 1.0000 * N99 = 0 ;
- 0.7076 * N57 - 1.0000 * N95 - 0.7076 * N96 = 0 ;
- 0.7066 * N98 - 1.0000 * N99 = 0 ;
- 1.0000 * N31 - 0.7076 * N98 = 0 ;

@BND(-600102.1600,N1,254620.0000);
@BND(-443640.1200,N2,0.0000);
@BND(0.0000,N3,0.0000);
@BND(-600102.1600,N4,254620.0000);
@BND(-443640.1200,N5,0.0000);
@BND(-600102.1600,N6,254620.0000);
@BND(-443640.1200,N7,0.0000);
@BND(-600102.1600,N8,254620.0000);
@BND(-443640.1200,N9,0.0000);
@BND(-600102.1600,N10,254620.0000);
@BND(-443640.1200,N11,0.0000);
@BND(-600102.1600,N12,254620.0000);
@BND(-443640.1200,N13,0.0000);
@BND(-600102.1600,N14,254620.0000);
@BND(-443640.1200,N15,0.0000);
@BND(-600102.1600,N16,254620.0000);
@BND(-443640.1200,N17,0.0000);
@BND(-600102.1600,N18,254620.0000);
@BND(-443640.1200,N19,0.0000);
@BND(-600102.1600,N20,254620.0000);
@BND(-443640.1200,N21,0.0000);
@BND(-600102.1600,N22,254620.0000);
@BND(-443640.1200,N23,0.0000);
@BND(-600102.1600,N24,254620.0000);
@BND(-443640.1200,N25,0.0000);
@BND(0.0000,N26,182497.5900);
@BND(-600102.1600,N27,254620.0000);
@BND(-443640.1200,N28,0.0000);
```

```
@BND(-600102.1600,N29,254620.0000);
@BND(-443640.1200,N30,0.0000);
@BND(0.0000,N31,0.0000);
@BND(-443640.1200,N32,0.0000);
@BND(-443640.1200,N33,0.0000);
@BND(-443640.1200,N34,0.0000);
@BND(-443640.1200,N35,0.0000);
@BND(-443640.1200,N36,0.0000);
@BND(-443640.1200,N37,0.0000);
@BND(-443640.1200,N38,0.0000);
@BND(-443640.1200,N39,0.0000);
@BND(-443640.1200,N40,0.0000);
@BND(-443640.1200,N41,0.0000);
@BND(-443640.1200,N42,0.0000);
@BND(-443640.1200,N43,0.0000);
@BND(-443640.1200,N44,0.0000);
@BND(-443640.1200,N45,0.0000);
@BND(-443640.1200,N46,0.0000);
@BND(-443640.1200,N47,0.0000);
@BND(-443640.1200,N48,0.0000);
@BND(-443640.1200,N49,0.0000);
@BND(-443640.1200,N50,0.0000);
@BND(-443640.1200,N51,0.0000);
@BND(-443640.1200,N52,0.0000);
@BND(-443640.1200,N53,0.0000);
@BND(-443640.1200,N54,0.0000);
@BND(-443640.1200,N55,0.0000);
@BND(-443640.1200,N56,0.0000);
@BND(-443640.1200,N57,0.0000);
@BND(-443640.1200,N58,0.0000);
@BND(-443640.1200,N59,0.0000);
@BND(-386890.1600,N60,41408.0000);
@BND(0.0000,N61,162780.4800);
@BND(-443640.1200,N62,0.0000);
@BND(-386890.1600,N63,41408.0000);
@BND(0.0000,N64,162780.4800);
@BND(-443640.1200,N65,0.0000);
@BND(-386890.1600,N66,41408.0000);
@BND(0.0000,N67,162780.4800);
@BND(-443640.1200,N68,0.0000);
@BND(-386890.1600,N69,41408.0000);
@BND(0.0000,N70,162780.4800);
@BND(-443640.1200,N71,0.0000);
@BND(-386890.1600,N72,41408.0000);
@BND(0.0000,N73,162780.4800);
@BND(-443640.1200,N74,0.0000);
@BND(-386890.1600,N75,41408.0000);
@BND(0.0000,N76,162780.4800);
@BND(-443640.1200,N77,0.0000);
@BND(-386890.1600,N78,41408.0000);
@BND(0.0000,N79,162780.4800);
@BND(-443640.1200,N80,0.0000);
@BND(-564282.1600,N81,218800.0000);
@BND(0.0000,N82,162780.4800);
@BND(-443640.1200,N83,0.0000);
@BND(0.0000,N84,162780.4800);
@BND(-443640.1200,N85,0.0000);
@BND(-564282.1600,N86,218800.0000);
@BND(0.0000,N87,182497.5900);
@BND(-443640.1200,N88,0.0000);
@BND(-564282.1600,N89,218800.0000);
```

```
@BND(-443640.1200,N90,0.0000);
@BND(-564282.1600,N91,218800.0000);
@BND(-564282.1600,N92,218800.0000);
@BND(0.0000,N93,182497.5900);
@BND(-443640.1200,N94,0.0000);
@BND(0.0000,N95,182497.5900);
@BND(-443640.1200,N96,0.0000);
@BND(-564282.1600,N97,218800.0000);
@BND(-443640.1200,N98,0.0000);
@BND(-564282.1600,N99,218800.0000);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N98);
@FREE(N99);

END
```

- **Resultado da Carga de Colapso:**

```
Global optimal solution found at step:          40
 Objective value:                          82378.75

                Variable           Value        Reduced Cost
                       P         82378.75         0.0000000
                      N1         9026.831         0.0000000
                      N4         59461.66         0.0000000
                      N5        0.0000000         0.0000000
                     N34        -71376.78         0.0000000
                     N61         50506.21         0.0000000
                      N6         109896.5         0.0000000
                      N7        -71376.78         0.0000000
                     N35        0.0000000         0.0000000
                     N64         50506.21         0.0000000
                      N8         160331.3         0.0000000
                      N9        0.0000000         0.0000000
                     N38        -71376.78         0.0000000
                     N67         50506.21         0.0000000
                     N10         210766.2         0.0000000
                     N11        -71376.78         0.0000000
                     N39        0.0000000         0.0000000
                     N70         50506.21         0.0000000
                     N12         254620.0        -0.2960265
                     N13        0.0000000         0.0000000
                     N42        -62063.18         0.0000000
                     N73         43915.91         0.0000000
                     N14         254620.0         0.0000000
                     N15        0.0000000         0.0000000
                     N43        0.0000000         0.0000000
                     N76        0.0000000         0.0000000
                     N16         222792.5         0.0000000
                     N17        -45043.16         0.0000000
                     N46        0.0000000         0.0000000
                     N79         31872.54         0.0000000
                     N18         190965.0         0.0000000
                     N19        0.0000000         0.0000000
                     N47        -45043.16         0.0000000
                     N82         31872.54         0.0000000
                     N20         159137.5         0.0000000
                     N21        -45043.16         0.0000000
                     N50        0.0000000         0.0000000
                     N84         31872.54         0.0000000
                     N22         127310.0         0.0000000
                     N23        0.0000000         0.0000000
                     N51        -45043.16         0.0000000
                     N87         31872.54         0.0000000
                     N24         95482.50         0.0000000
                     N25        -45043.16         0.0000000
                     N54        0.0000000         0.0000000
                     N26         31872.54         0.0000000
                     N27         63655.00         0.0000000
                     N28        0.0000000         0.0000000
                     N55        -45043.16         0.0000000
                     N93         31872.54         0.0000000
                     N29         31827.50         0.0000000
                     N30        -45043.16         0.0000000
                     N58        0.0000000         0.0000000
                     N95         31872.54         0.0000000
```

N59	-45043.16	0.0000000
N2	-71376.78	0.0000000
N32	0.0000000	-0.1195270
N33	-71376.78	0.0000000
N62	0.0000000	0.0000000
N65	-71376.78	0.0000000
N36	0.0000000	0.0000000
N37	-71376.78	0.0000000
N68	0.0000000	0.0000000
N71	-71376.78	0.0000000
N40	0.0000000	0.0000000
N41	-71376.78	0.0000000
N74	0.0000000	-0.2091723
N77	-62063.18	0.0000000
N44	-45043.16	0.0000000
N45	0.0000000	0.0000000
N80	-45043.16	0.0000000
N83	0.0000000	0.0000000
N48	-45043.16	0.0000000
N49	0.0000000	0.0000000
N85	-45043.16	0.0000000
N88	0.0000000	0.0000000
N52	-45043.16	0.0000000
N53	0.0000000	0.0000000
N90	-45043.16	0.0000000
N94	0.0000000	0.0000000
N56	-45043.16	0.0000000
N57	0.0000000	0.0000000
N96	-45043.16	0.0000000
N98	0.0000000	0.0000000
N60	41408.00	-0.1691580
N63	-9026.831	0.0000000
N66	-59461.66	0.0000000
N69	-109896.5	0.0000000
N72	-160331.3	0.0000000
N75	-210766.2	0.0000000
N78	-222792.5	0.0000000
N81	-190965.0	0.0000000
N86	-159137.5	0.0000000
N89	-127310.0	0.0000000
N91	-95482.50	0.0000000
N92	-63655.00	0.0000000
N97	-31827.50	0.0000000
N99	0.0000000	0.0000000
N31	0.0000000	0.0000000
N3	0.0000000	0.0000000

- **Dimensionamento:**

```
DATA:
P = 58842;
ENDDATA

min = (A1 * 28.57  + A4 * 28.57  + A6 * 28.57  + A8 * 28.57  + A10
* 28.57  + A12 * 28.57  + A14 * 28.57  + A16 * 28.57  + A18 *
28.57  + A20 * 28.57  + A22 * 28.57  + A24 * 28.57  + A27 * 28.57
+ A29 * 28.57  + A60 * 28.57  + A63 * 28.57  + A66 * 28.57  + A69
* 28.57  + A72 * 28.57  + A75 * 28.57  + A78 * 28.57  + A81 *
28.57  + A86 * 28.57  + A89 * 28.57  + A91 * 28.57  + A92 * 28.57
+ A97 * 28.57  + A99 * 28.57  + A61 * 28.61  + A64 * 28.61  + A67
* 28.61  + A70 * 28.61  + A73 * 28.61  + A76 * 28.61  + A79 *
28.61  + A82 * 28.61  + A84 * 28.61  + A87 * 28.61  + A26 * 28.61
+ A93 * 28.61  + A95 * 28.61 );

- 1.0000 * N1 + 1.0000 * N4 - 0.7066 * N5 + 0.7066 * N34 = 0 ;
+ 0.7076 * N5 + 0.7076 * N34 + 1.0000 * N61 = 0 ;
- 1.0000 * N4 + 1.0000 * N6 + 0.7066 * N7 - 0.7066 * N35 = 0 ;
+ 0.7076 * N7 + 0.7076 * N35 + 1.0000 * N64 = 0 ;
- 1.0000 * N6 + 1.0000 * N8 - 0.7066 * N9 + 0.7066 * N38 = 0 ;
+ 0.7076 * N9 + 0.7076 * N38 + 1.0000 * N67 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7066 * N11 - 0.7066 * N39 = 0 ;
+ 0.7076 * N11 + 0.7076 * N39 + 1.0000 * N70 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7066 * N13 + 0.7066 * N42 = 0 ;
+ 0.7076 * N13 + 0.7076 * N42 + 1.0000 * N73 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7066 * N15 - 0.7066 * N43 = 0 ;
+ 0.7076 * N15 + 0.7076 * N43 + 1.0000 * N76 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7066 * N17 + 0.7066 * N46 = 0 ;
+ 0.7076 * N17 + 0.7076 * N46 + 1.0000 * N79 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7066 * N19 - 0.7066 * N47 = 0 ;
+ 0.7076 * N19 + 0.7076 * N47 + 1.0000 * N82 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7066 * N21 + 0.7066 * N50 = 0 ;
+ 0.7076 * N21 + 0.7076 * N50 + 1.0000 * N84 = 0 ;
- 1.0000 * N20 + 1.0000 * N22 + 0.7066 * N23 - 0.7066 * N51 = 0 ;
+ 0.7076 * N23 + 0.7076 * N51 + 1.0000 * N87 = 0 ;
- 1.0000 * N22 + 1.0000 * N24 - 0.7066 * N25 + 0.7066 * N54 = 0 ;
+ 0.7076 * N25 + 1.0000 * N26 + 0.7076 * N54 = 0 ;
- 1.0000 * N24 + 1.0000 * N27 + 0.7066 * N28 - 0.7066 * N55 = 0 ;
+ 0.7076 * N28 + 0.7076 * N55 + 1.0000 * N93 = 0 ;
- 1.0000 * N27 + 1.0000 * N29 - 0.7066 * N30 + 0.7066 * N58 = 0 ;
+ 0.7076 * N30 + 0.7076 * N58 + 1.0000 * N95 = 0 ;
- 1.0000 * N29 - 0.7066 * N59 = 0 ;
- 0.7066 * N2 + 0.7066 * N5 - 0.7066 * N32 + 0.7066 * N33 = 0 ;
- 0.7076 * N2 - 0.7076 * N5 + 0.7076 * N32 + 0.7076 * N33 = 0 ;
- 0.7066 * N34 + 0.7066 * N35 - 0.7066 * N62 + 0.7066 * N65 = 0 ;
- 0.7076 * N34 - 0.7076 * N35 + 0.7076 * N62 + 0.7076 * N65 = 0 ;
- 0.7066 * N7 + 0.7066 * N9 - 0.7066 * N36 + 0.7066 * N37 = 0 ;
- 0.7076 * N7 - 0.7076 * N9 + 0.7076 * N36 + 0.7076 * N37 = 0 ;
- 0.7066 * N38 + 0.7066 * N39 - 0.7066 * N68 + 0.7066 * N71 = 0 ;
- 0.7076 * N38 - 0.7076 * N39 + 0.7076 * N68 + 0.7076 * N71 = 0 ;
- 0.7066 * N11 + 0.7066 * N13 - 0.7066 * N40 + 0.7066 * N41 = 0 ;
- 0.7076 * N11 - 0.7076 * N13 + 0.7076 * N40 + 0.7076 * N41 = 0 ;
- 0.7066 * N42 + 0.7066 * N43 - 0.7066 * N74 + 0.7066 * N77 = 0 ;
- 0.7076 * N42 - 0.7076 * N43 + 0.7076 * N74 + 0.7076 * N77 = 0 ;
- 0.7066 * N15 + 0.7066 * N17 - 0.7066 * N44 + 0.7066 * N45 = 0 ;
- 0.7076 * N15 - 0.7076 * N17 + 0.7076 * N44 + 0.7076 * N45 = 0 ;
- 0.7066 * N46 + 0.7066 * N47 - 0.7066 * N80 + 0.7066 * N83 = 0 ;
- 0.7076 * N46 - 0.7076 * N47 + 0.7076 * N80 + 0.7076 * N83 = 0 ;
```

```
- 0.7066 * N19 + 0.7066 * N21 - 0.7066 * N48 + 0.7066 * N49 = 0 ;
- 0.7076 * N19 - 0.7076 * N21 + 0.7076 * N48 + 0.7076 * N49 = 0 ;
- 0.7066 * N50 + 0.7066 * N51 - 0.7066 * N85 + 0.7066 * N88 = 0 ;
- 0.7076 * N50 - 0.7076 * N51 + 0.7076 * N85 + 0.7076 * N88 = 0 ;
- 0.7066 * N23 + 0.7066 * N25 - 0.7066 * N52 + 0.7066 * N53 = 0 ;
- 0.7076 * N23 - 0.7076 * N25 + 0.7076 * N52 + 0.7076 * N53 = 0 ;
- 0.7066 * N54 + 0.7066 * N55 - 0.7066 * N90 + 0.7066 * N94 = 0 ;
- 0.7076 * N54 - 0.7076 * N55 + 0.7076 * N90 + 0.7076 * N94 = 0 ;
- 0.7066 * N28 + 0.7066 * N30 - 0.7066 * N56 + 0.7066 * N57 = 0 ;
- 0.7076 * N28 - 0.7076 * N30 + 0.7076 * N56 + 0.7076 * N57 = 0 ;
- 0.7066 * N58 + 0.7066 * N59 - 0.7066 * N96 + 0.7066 * N98 = 0 ;
- 0.7076 * N58 - 0.7076 * N59 + 0.7076 * N96 + 0.7076 * N98 = 0 ;
- 0.7066 * N33 - 1.0000 * N60 + 0.7066 * N62 + 1.0000 * N63 = 0 ;
- 0.7076 * N33 - 1.0000 * N61 - 0.7076 * N62 = 0 ;
+ 0.7066 * N36 - 1.0000 * N63 - 0.7066 * N65 + 1.0000 * N66 = 0 ;
- 0.7076 * N36 - 1.0000 * N64 - 0.7076 * N65 = 0 ;
- 0.7066 * N37 - 1.0000 * N66 + 0.7066 * N68 + 1.0000 * N69 = 0 ;
- 0.7076 * N37 - 1.0000 * N67 - 0.7076 * N68 = 0 ;
+ 0.7066 * N40 - 1.0000 * N69 - 0.7066 * N71 + 1.0000 * N72 = 0 ;
- 0.7076 * N40 - 1.0000 * N70 - 0.7076 * N71 = 0 ;
- 0.7066 * N41 - 1.0000 * N72 + 0.7066 * N74 + 1.0000 * N75 = 0 ;
- 0.08 * P - 0.7076 * N41 - 1.0000 * N73 - 0.7076 * N74 = 0 ;
+ 0.7066 * N44 - 1.0000 * N75 - 0.7066 * N77 + 1.0000 * N78 = 0 ;
- 0.92 * P - 0.7076 * N44 - 1.0000 * N76 - 0.7076 * N77 = 0 ;
- 0.7066 * N45 - 1.0000 * N78 + 0.7066 * N80 + 1.0000 * N81 = 0 ;
- 0.7076 * N45 - 1.0000 * N79 - 0.7076 * N80 = 0 ;
+ 0.7066 * N48 - 1.0000 * N81 - 0.7066 * N83 + 1.0000 * N86 = 0 ;
- 0.7076 * N48 - 1.0000 * N82 - 0.7076 * N83 = 0 ;
- 0.7066 * N49 + 0.7066 * N85 - 1.0000 * N86 + 1.0000 * N89 = 0 ;
- 0.7076 * N49 - 1.0000 * N84 - 0.7076 * N85 = 0 ;
+ 0.7066 * N52 - 0.7066 * N88 - 1.0000 * N89 + 1.0000 * N91 = 0 ;
- 0.7076 * N52 - 1.0000 * N87 - 0.7076 * N88 = 0 ;
- 0.7066 * N53 + 0.7066 * N90 - 1.0000 * N91 + 1.0000 * N92 = 0 ;
- 1.0000 * N26 - 0.7076 * N53 - 0.7076 * N90 = 0 ;
+ 0.7066 * N56 - 1.0000 * N92 - 0.7066 * N94 + 1.0000 * N97 = 0 ;
- 0.7076 * N56 - 1.0000 * N93 - 0.7076 * N94 = 0 ;
- 0.7066 * N57 + 0.7066 * N96 - 1.0000 * N97 + 1.0000 * N99 = 0 ;
- 0.7076 * N57 - 1.0000 * N95 - 0.7076 * N96 = 0 ;
- 0.7066 * N98 - 1.0000 * N99 = 0 ;
- 1.0000 * N31 - 0.7076 * N98 = 0 ;
N61 - 56260.87 * A61 <=0;
N64 - 56260.87 * A64 <=0;
N67 - 56260.87 * A67 <=0;
N70 - 56260.87 * A70 <=0;
N73 - 56260.87 * A73 <=0;
N76 - 56260.87 * A76 <=0;
N79 - 56260.87 * A79 <=0;
N82 - 56260.87 * A82 <=0;
N84 - 56260.87 * A84 <=0;
N87 - 56260.87 * A87 <=0;
N26 - 56260.87 * A26 <=0;
N93 - 56260.87 * A93 <=0;
N95 - 56260.87 * A95 <=0;
N1 - 50434.78 * A1 <= 0;
246772.97 + 50434.78 * A1 + N1 >= 0;
N4 - 50434.78 * A4 <= 0;
246772.97 + 50434.78 * A4 + N4 >= 0;
N6 - 50434.78 * A6 <= 0;
246772.97 + 50434.78 * A6 + N6 >= 0;
N8 - 50434.78 * A8 <= 0;
246772.97 + 50434.78 * A8 + N8 >= 0;
```

```
N10 – 50434.78 * A10 <= 0;
246772.97 + 50434.78 * A10 + N10 >= 0;
N12 – 50434.78 * A12 <= 0;
246772.97 + 50434.78 * A12 + N12 >= 0;
N14 – 50434.78 * A14 <= 0;
246772.97 + 50434.78 * A14 + N14 >= 0;
N16 – 50434.78 * A16 <= 0;
246772.97 + 50434.78 * A16 + N16 >= 0;
N18 – 50434.78 * A18 <= 0;
246772.97 + 50434.78 * A18 + N18 >= 0;
N20 – 50434.78 * A20 <= 0;
246772.97 + 50434.78 * A20 + N20 >= 0;
N22 – 50434.78 * A22 <= 0;
246772.97 + 50434.78 * A22 + N22 >= 0;
N24 – 50434.78 * A24 <= 0;
246772.97 + 50434.78 * A24 + N24 >= 0;
N27 – 50434.78 * A27 <= 0;
246772.97 + 50434.78 * A27 + N27 >= 0;
N29 – 50434.78 * A29 <= 0;
246772.97 + 50434.78 * A29 + N29 >= 0;
N60 – 56260.87 * A60 <= 0;
246772.97 + 56260.87 * A60 + N60 >= 0;
N63 – 56260.87 * A63 <= 0;
246772.97 + 56260.87 * A63 + N63 >= 0;
N66 – 56260.87 * A66 <= 0;
246772.97 + 56260.87 * A66 + N66 >= 0;
N69 – 56260.87 * A69 <= 0;
246772.97 + 56260.87 * A69 + N69 >= 0;
N72 – 56260.87 * A72 <= 0;
246772.97 + 56260.87 * A72 + N72 >= 0;
N75 – 56260.87 * A75 <= 0;
246772.97 + 56260.87 * A75 + N75 >= 0;
N78 – 56260.87 * A78 <= 0;
246772.97 + 56260.87 * A78 + N78 >= 0;
N81 – 47565.22 * A81 <= 0;
246772.97 + 47565.22 * A81 + N81 >= 0;
N86 – 47565.22 * A86 <= 0;
246772.97 + 47565.22 * A86 + N86 >= 0;
N89 – 47565.22 * A89 <= 0;
246772.97 + 47565.22 * A89 + N89 >= 0;
N91 – 47565.22 * A91 <= 0;
246772.97 + 47565.22 * A91 + N91 >= 0;
N92 – 47565.22 * A92 <= 0;
246772.97 + 47565.22 * A92 + N92 >= 0;
N97 – 47565.22 * A97 <= 0;
246772.97 + 47565.22 * A97 + N97 >= 0;
N99 – 47565.22 * A99 <= 0;
246772.97 + 47565.22 * A99 + N99 >= 0;

@BND(-600102.1600,N1,254620.0000);
@BND(-443640.1200,N2,0.0000);
@BND(0.0000,N3,0.0000);
@BND(-600102.1600,N4,254620.0000);
@BND(-443640.1200,N5,0.0000);
@BND(-600102.1600,N6,254620.0000);
@BND(-443640.1200,N7,0.0000);
@BND(-600102.1600,N8,254620.0000);
@BND(-443640.1200,N9,0.0000);
@BND(-600102.1600,N10,254620.0000);
@BND(-443640.1200,N11,0.0000);
@BND(-600102.1600,N12,254620.0000);
```

```
@BND(-443640.1200,N13,0.0000);
@BND(-600102.1600,N14,254620.0000);
@BND(-443640.1200,N15,0.0000);
@BND(-600102.1600,N16,254620.0000);
@BND(-443640.1200,N17,0.0000);
@BND(-600102.1600,N18,254620.0000);
@BND(-443640.1200,N19,0.0000);
@BND(-600102.1600,N20,254620.0000);
@BND(-443640.1200,N21,0.0000);
@BND(-600102.1600,N22,254620.0000);
@BND(-443640.1200,N23,0.0000);
@BND(-600102.1600,N24,254620.0000);
@BND(-443640.1200,N25,0.0000);
@BND(0.0000,N26,182497.5900);
@BND(-600102.1600,N27,254620.0000);
@BND(-443640.1200,N28,0.0000);
@BND(-600102.1600,N29,254620.0000);
@BND(-443640.1200,N30,0.0000);
@BND(0.0000,N31,0.0000);
@BND(-443640.1200,N32,0.0000);
@BND(-443640.1200,N33,0.0000);
@BND(-443640.1200,N34,0.0000);
@BND(-443640.1200,N35,0.0000);
@BND(-443640.1200,N36,0.0000);
@BND(-443640.1200,N37,0.0000);
@BND(-443640.1200,N38,0.0000);
@BND(-443640.1200,N39,0.0000);
@BND(-443640.1200,N40,0.0000);
@BND(-443640.1200,N41,0.0000);
@BND(-443640.1200,N42,0.0000);
@BND(-443640.1200,N43,0.0000);
@BND(-443640.1200,N44,0.0000);
@BND(-443640.1200,N45,0.0000);
@BND(-443640.1200,N46,0.0000);
@BND(-443640.1200,N47,0.0000);
@BND(-443640.1200,N48,0.0000);
@BND(-443640.1200,N49,0.0000);
@BND(-443640.1200,N50,0.0000);
@BND(-443640.1200,N51,0.0000);
@BND(-443640.1200,N52,0.0000);
@BND(-443640.1200,N53,0.0000);
@BND(-443640.1200,N54,0.0000);
@BND(-443640.1200,N55,0.0000);
@BND(-443640.1200,N56,0.0000);
@BND(-443640.1200,N57,0.0000);
@BND(-443640.1200,N58,0.0000);
@BND(-443640.1200,N59,0.0000);
@BND(-386890.1600,N60,41408.0000);
@BND(0.0000,N61,162780.4800);
@BND(-443640.1200,N62,0.0000);
@BND(-386890.1600,N63,41408.0000);
@BND(0.0000,N64,162780.4800);
@BND(-443640.1200,N65,0.0000);
@BND(-386890.1600,N66,41408.0000);
@BND(0.0000,N67,162780.4800);
@BND(-443640.1200,N68,0.0000);
@BND(-386890.1600,N69,41408.0000);
@BND(0.0000,N70,162780.4800);
@BND(-443640.1200,N71,0.0000);
@BND(-386890.1600,N72,41408.0000);
@BND(0.0000,N73,162780.4800);
```

```
@BND(-443640.1200,N74,0.0000);
@BND(-386890.1600,N75,41408.0000);
@BND(0.0000,N76,162780.4800);
@BND(-443640.1200,N77,0.0000);
@BND(-386890.1600,N78,41408.0000);
@BND(0.0000,N79,162780.4800);
@BND(-443640.1200,N80,0.0000);
@BND(-564282.1600,N81,218800.0000);
@BND(0.0000,N82,162780.4800);
@BND(-443640.1200,N83,0.0000);
@BND(0.0000,N84,162780.4800);
@BND(-443640.1200,N85,0.0000);
@BND(-564282.1600,N86,218800.0000);
@BND(0.0000,N87,182497.5900);
@BND(-443640.1200,N88,0.0000);
@BND(-564282.1600,N89,218800.0000);
@BND(-443640.1200,N90,0.0000);
@BND(-564282.1600,N91,218800.0000);
@BND(-564282.1600,N92,218800.0000);
@BND(0.0000,N93,182497.5900);
@BND(-443640.1200,N94,0.0000);
@BND(0.0000,N95,182497.5900);
@BND(-443640.1200,N96,0.0000);
@BND(-564282.1600,N97,218800.0000);
@BND(-443640.1200,N98,0.0000);
@BND(-564282.1600,N99,218800.0000);
@BND(0.79,A1,21);
@BND(0.79,A4,21);
@BND(0.79,A6,21);
@BND(0.79,A8,21);
@BND(0.79,A10,21);
@BND(0.79,A12,21);
@BND(0.79,A14,21);
@BND(0.79,A16,21);
@BND(0.79,A18,21);
@BND(0.79,A20,21);
@BND(0.79,A22,21);
@BND(0.79,A24,21);
@BND(0.79,A27,21);
@BND(0.79,A29,21);
@BND(0.79,A60,21);
@BND(0.79,A63,21);
@BND(0.79,A66,21);
@BND(0.79,A69,21);
@BND(0.79,A72,21);
@BND(0.79,A75,21);
@BND(0.79,A78,21);
@BND(0.79,A81,21);
@BND(0.79,A86,21);
@BND(0.79,A89,21);
@BND(0.79,A91,21);
@BND(0.79,A92,21);
@BND(0.79,A97,21);
@BND(0.79,A99,21);
@BND(0.47,A61,17.14);
@BND(0.47,A64,17.14);
@BND(0.47,A67,17.14);
@BND(0.47,A70,17.14);
@BND(0.47,A73,17.14);
@BND(0.47,A76,17.14);
@BND(0.47,A79,17.14);
```

```
@BND(0.47,A82,17.14);
@BND(0.47,A84,17.14);
@BND(0.47,A87,17.14);
@BND(0.47,A26,17.14);
@BND(0.47,A93,17.14);
@BND(0.47,A95,17.14);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N98);
@FREE(N99);

END
```

- **Resultado do Dimensionamento:**

```
Optimal solution found at step:         135
Objective value:                    1296.193
```

Variable	Value	Reduced Cost
P	58842.00	0.0000000
A1	0.7900000	28.57000
A4	0.7900000	28.57000
A6	1.372106	0.0000000
A8	2.103149	0.0000000
A10	2.834191	0.0000000
A12	3.472030	0.0000000
A14	3.472030	0.0000000
A16	3.038026	0.0000000
A18	2.604022	0.0000000
A20	2.170019	0.0000000
A22	1.736015	0.0000000
A24	1.302011	0.0000000
A27	0.8680074	0.0000000
A29	0.7900000	28.57000
A60	0.7900000	28.57000
A63	0.7900000	28.57000
A66	0.7900000	28.57000
A69	0.7900000	28.57000
A72	0.7900000	28.57000
A75	0.7900000	28.57000
A78	0.7900000	28.57000
A81	0.7900000	28.57000
A86	0.7900000	28.57000
A89	0.7900000	28.57000
A91	0.7900000	28.57000
A92	0.7900000	28.57000
A97	0.7900000	28.57000
A99	0.7900000	28.57000
A61	0.6562668	0.0000000
A64	0.6562668	0.0000000
A67	0.6562668	0.0000000
A70	0.6562668	0.0000000
A73	0.5725966	0.0000000
A76	0.4700000	28.61000
A79	0.4700000	28.61000
A82	0.4700000	28.61000
A84	0.4700000	28.61000
A87	0.4700000	28.61000
A26	0.4700000	28.61000
A93	0.4700000	28.61000
A95	0.4700000	28.61000
N1	-4538.039	0.0000000
N4	32331.92	0.0000000
N5	0.0000000	0.0000000
N34	-52179.40	0.0000000
N61	36922.14	0.0000000
N6	69201.88	0.0000000
N7	-52179.40	0.0000000
N35	0.0000000	-0.7196629E-03
N64	36922.14	0.0000000
N8	106071.8	0.0000000

```
N9      0.0000000              0.0000000
N38    -52179.40              0.0000000
N67     36922.14              0.0000000
N10     142941.8              0.0000000
N11    -52179.40              0.0000000
N39     0.0000000              0.0000000
N70     36922.14              0.0000000
N12     175111.1              0.0000000
N13     0.0000000             -0.1119934E-02
N42    -45526.82              0.0000000
N73     32214.78              0.0000000
N14     175111.1              0.0000000
N15     0.0000000             -0.4002714E-03
N43     0.0000000             -0.7601028E-03
N76     0.0000000              0.0000000
N16     153222.2              0.0000000
N17    -30977.76              0.0000000
N46     0.0000000              0.0000000
N79     21919.86              0.0000000
N18     131333.3              0.0000000
N19     0.0000000              0.0000000
N47    -30977.76              0.0000000
N82     21919.86              0.0000000
N20     109444.4              0.0000000
N21    -30977.76              0.0000000
N50     0.0000000              0.0000000
N84     21919.86              0.0000000
N22     87555.53              0.0000000
N23     0.0000000             -0.4002700E-03
N51    -30977.76              0.0000000
N87     21919.86              0.0000000
N24     65666.65              0.0000000
N25    -30977.76              0.0000000
N54     0.0000000              0.0000000
N26     21919.86              0.0000000
N27     43777.76              0.0000000
N28     0.0000000             -0.4002708E-03
N55    -30977.76              0.0000000
N93     21919.86              0.0000000
N29     21888.88              0.0000000
N30    -30977.76              0.0000000
N58     0.0000000              0.0000000
N95     21919.86              0.0000000
N59    -30977.76              0.0000000
N2     -52179.40              0.0000000
N32     0.0000000             -0.2318446E-02
N33    -52179.40              0.0000000
N62     0.0000000              0.0000000
N65    -52179.40              0.0000000
N36     0.0000000             -0.1119934E-02
N37    -52179.40              0.0000000
N68     0.0000000             -0.1119934E-02
N71    -52179.40              0.0000000
N40     0.0000000              0.0000000
N41    -52179.40              0.0000000
N74     0.0000000              0.0000000
N77    -45526.82              0.0000000
N44    -30977.76              0.0000000
N45     0.0000000              0.0000000
N80    -30977.76              0.0000000
N83     0.0000000             -0.4002703E-03
```

```
N48        -30977.76             0.0000000
N49         0.0000000           -0.4002705E-03
N85        -30977.76             0.0000000
N88         0.0000000           -0.4002707E-03
N52        -30977.76             0.0000000
N53         0.0000000            0.0000000
N90        -30977.76             0.0000000
N94         0.0000000           -0.4002706E-03
N56        -30977.76             0.0000000
N57         0.0000000            0.0000000
N96        -30977.76             0.0000000
N98         0.0000000            0.0000000
N60         41408.00            -0.2771885E-02
N63         4538.039             0.0000000
N66        -32331.92             0.0000000
N69        -69201.88             0.0000000
N72        -106071.8             0.0000000
N75        -142941.8             0.0000000
N78        -153222.2             0.0000000
N81        -131333.3             0.0000000
N86        -109444.4             0.0000000
N89        -87555.53             0.0000000
N91        -65666.65             0.0000000
N92        -43777.76             0.0000000
N97        -21888.88             0.0000000
N99         0.0000000            0.0000000
N31         0.0000000            0.8673617E-18
 N3         0.0000000            0.0000000
```

→ EXEMPLO 4

- **Carga de Colapso:**

```
model:

 max =P;

- 1.0000 * N1 + 1.0000 * N4 - 0.7055 * N5 + 0.7055 * N39 = 0 ;
+ 0.7087 * N5 + 1.0000 * N6 + 0.7087 * N39 = 0 ;
- 1.0000 * N4 + 1.0000 * N7 + 0.7055 * N8 - 0.7055 * N40 = 0 ;
+ 0.7087 * N8 + 1.0000 * N9 + 0.7087 * N40 = 0 ;
- 1.0000 * N7 + 1.0000 * N10 - 0.7055 * N11 + 0.7055 * N43 = 0 ;
+ 0.7087 * N11 + 1.0000 * N12 + 0.7087 * N43 = 0 ;
- 1.0000 * N10 + 1.0000 * N13 + 0.7055 * N14 - 0.7055 * N44 = 0 ;
+ 0.7087 * N14 + 1.0000 * N15 + 0.7087 * N44 = 0 ;
- 1.0000 * N13 + 1.0000 * N16 - 0.7055 * N17 + 0.7055 * N47 = 0 ;
+ 0.7087 * N17 + 1.0000 * N18 + 0.7087 * N47 = 0 ;
- 1.0000 * N16 + 1.0000 * N19 + 0.7055 * N20 - 0.7055 * N48 = 0 ;
+ 0.7087 * N20 + 1.0000 * N21 + 0.7087 * N48 = 0 ;
- 1.0000 * N19 + 1.0000 * N22 - 0.7055 * N23 + 0.7055 * N51 = 0 ;
+ 0.7087 * N23 + 1.0000 * N24 + 0.7087 * N51 = 0 ;
- 1.0000 * N22 + 1.0000 * N25 + 0.7055 * N26 - 0.7055 * N52 = 0 ;
+ 0.7087 * N26 + 1.0000 * N27 + 0.7087 * N52 = 0 ;
- 1.0000 * N25 + 1.0000 * N28 - 0.7055 * N29 + 0.7055 * N55 = 0 ;
+ 0.7087 * N29 + 1.0000 * N30 + 0.7087 * N55 = 0 ;
- 1.0000 * N28 + 1.0000 * N31 + 0.7055 * N32 - 0.7055 * N56 = 0 ;
+ 0.7087 * N32 + 1.0000 * N33 + 0.7087 * N56 = 0 ;
- 1.0000 * N31 + 1.0000 * N34 - 0.7055 * N35 + 0.7055 * N59 = 0 ;
+ 0.7087 * N35 + 1.0000 * N36 + 0.7087 * N59 = 0 ;
- 1.0000 * N34 - 0.7055 * N60 = 0 ;
- 0.7055 * N2 + 0.7055 * N5 - 0.7055 * N37 + 0.7055 * N38 = 0 ;
- 0.7087 * N2 - 0.7087 * N5 + 0.7087 * N37 + 0.7087 * N38 = 0 ;
- 0.7055 * N39 + 0.7055 * N40 - 0.7055 * N62 + 0.7055 * N64 = 0 ;
- 0.7087 * N39 - 0.7087 * N40 + 0.7087 * N62 + 0.7087 * N64 = 0 ;
- 0.7055 * N8 + 0.7055 * N11 - 0.7055 * N41 + 0.7055 * N42 = 0 ;
- 0.7087 * N8 - 0.7087 * N11 + 0.7087 * N41 + 0.7087 * N42 = 0 ;
- 0.7055 * N43 + 0.7055 * N44 - 0.7055 * N66 + 0.7055 * N68 = 0 ;
- 0.7087 * N43 - 0.7087 * N44 + 0.7087 * N66 + 0.7087 * N68 = 0 ;
- 0.7055 * N14 + 0.7055 * N17 - 0.7055 * N45 + 0.7055 * N46 = 0 ;
- 0.7087 * N14 - 0.7087 * N17 + 0.7087 * N45 + 0.7087 * N46 = 0 ;
- 0.7055 * N47 + 0.7055 * N48 - 0.7055 * N70 + 0.7055 * N72 = 0 ;
- 0.7087 * N47 - 0.7087 * N48 + 0.7087 * N70 + 0.7087 * N72 = 0 ;
- 0.7055 * N20 + 0.7055 * N23 - 0.7055 * N49 + 0.7055 * N50 = 0 ;
- 0.7087 * N20 - 0.7087 * N23 + 0.7087 * N49 + 0.7087 * N50 = 0 ;
- 0.7055 * N51 + 0.7055 * N52 - 0.7055 * N74 + 0.7055 * N76 = 0 ;
- 0.7087 * N51 - 0.7087 * N52 + 0.7087 * N74 + 0.7087 * N76 = 0 ;
- 0.7055 * N26 + 0.7055 * N29 - 0.7055 * N53 + 0.7055 * N54 = 0 ;
- 0.7087 * N26 - 0.7087 * N29 + 0.7087 * N53 + 0.7087 * N54 = 0 ;
- 0.7055 * N55 + 0.7055 * N56 - 0.7055 * N78 + 0.7055 * N80 = 0 ;
- 0.7087 * N55 - 0.7087 * N56 + 0.7087 * N78 + 0.7087 * N80 = 0 ;
- 0.7055 * N32 + 0.7055 * N35 - 0.7055 * N57 + 0.7055 * N58 = 0 ;
- 0.7087 * N32 - 0.7087 * N35 + 0.7087 * N57 + 0.7087 * N58 = 0 ;
- 0.7055 * N59 + 0.7055 * N60 - 0.7055 * N82 + 0.7055 * N85 = 0 ;
- 0.7087 * N59 - 0.7087 * N60 + 0.7087 * N82 + 0.7087 * N85 = 0 ;
- 0.7055 * N38 - 1.0000 * N61 + 0.7055 * N62 + 1.0000 * N63 = 0 ;
- 1.0000 * N6 - 0.7087 * N38 - 0.7087 * N62 = 0 ;
+ 0.7055 * N41 - 1.0000 * N63 - 0.7055 * N64 + 1.0000 * N65 = 0 ;
- 1.0000 * N9 - 0.7087 * N41 - 0.7087 * N64 = 0 ;
- 0.7055 * N42 - 1.0000 * N65 + 0.7055 * N66 + 1.0000 * N67 = 0 ;
```

```
- 1.0000 * N12 - 0.7087 * N42 - 0.7087 * N66 = 0 ;
+ 0.7055 * N45 - 1.0000 * N67 - 0.7055 * N68 + 1.0000 * N69 = 0 ;
- 1.0000 * N15 - 0.7087 * N45 - 0.7087 * N68 = 0 ;
- 0.7055 * N46 - 1.0000 * N69 + 0.7055 * N70 + 1.0000 * N71 = 0 ;
- 1.0000 * N18 - 0.7087 * N46 - 0.7087 * N70 = 0 ;
+ 0.7055 * N49 - 1.0000 * N71 - 0.7055 * N72 + 1.0000 * N73 = 0 ;
- 1.0000 * P - 1.0000 * N21 - 0.7087 * N49 - 0.7087 * N72 = 0 ;
- 0.7055 * N50 - 1.0000 * N73 + 0.7055 * N74 + 1.0000 * N75 = 0 ;
- 1.0000 * N24 - 0.7087 * N50 - 0.7087 * N74 = 0 ;
+ 0.7055 * N53 - 1.0000 * N75 - 0.7055 * N76 + 1.0000 * N77 = 0 ;
- 1.0000 * N27 - 0.7087 * N53 - 0.7087 * N76 = 0 ;
- 0.7055 * N54 - 1.0000 * N77 + 0.7055 * N78 + 1.0000 * N79 = 0 ;
- 2.0000 * P - 1.0000 * N30 - 0.7087 * N54 - 0.7087 * N78 = 0 ;
+ 0.7055 * N57 - 1.0000 * N79 - 0.7055 * N80 + 1.0000 * N81 = 0 ;
- 1.0000 * N33 - 0.7087 * N57 - 0.7087 * N80 = 0 ;
- 0.7055 * N58 - 1.0000 * N81 + 0.7055 * N82 + 1.0000 * N83 = 0 ;
- 1.0000 * N36 - 0.7087 * N58 - 0.7087 * N82 = 0 ;
- 1.0000 * N83 - 0.7055 * N85 = 0 ;
- 1.0000 * N84 - 0.7087 * N85 = 0 ;

@BND(-323210.4800,N1,125000.0000);
@BND(-279415.1757,N2,0.0000);
@BND(0.0000,N3,0.0000);
@BND(-323210.4800,N4,125000.0000);
@BND(-279415.1757,N5,0.0000);
@BND(0.0000,N6,123235.1500);
@BND(-323210.4800,N7,125000.0000);
@BND(-279415.1757,N8,0.0000);
@BND(0.0000,N9,123235.1500);
@BND(-323210.4800,N10,125000.0000);
@BND(-279415.1757,N11,0.0000);
@BND(0.0000,N12,123235.1500);
@BND(-323210.4800,N13,125000.0000);
@BND(-279415.1757,N14,0.0000);
@BND(0.0000,N15,123235.1500);
@BND(-323210.4800,N16,125000.0000);
@BND(-279415.1757,N17,0.0000);
@BND(0.0000,N18,123235.1500);
@BND(-323210.4800,N19,125000.0000);
@BND(-279415.1757,N20,0.0000);
@BND(0.0000,N21,123235.1500);
@BND(-323210.4800,N22,125000.0000);
@BND(-279415.1757,N23,0.0000);
@BND(0.0000,N24,123235.1500);
@BND(-323210.4800,N25,125000.0000);
@BND(-279415.1757,N26,0.0000);
@BND(0.0000,N27,123235.1500);
@BND(-323210.4800,N28,125000.0000);
@BND(-279415.1757,N29,0.0000);
@BND(0.0000,N30,123235.1500);
@BND(-323210.4800,N31,125000.0000);
@BND(-279415.1757,N32,0.0000);
@BND(0.0000,N33,123235.1500);
@BND(-323210.4800,N34,125000.0000);
@BND(-279415.1757,N35,0.0000);
@BND(0.0000,N36,123235.1500);
@BND(-279415.1757,N37,0.0000);
@BND(-279415.1757,N38,0.0000);
@BND(-279415.1757,N39,0.0000);
@BND(-279415.1757,N40,0.0000);
@BND(-279415.1757,N41,0.0000);
```

```
@BND(-279415.1757,N42,0.0000);
@BND(-279415.1757,N43,0.0000);
@BND(-279415.1757,N44,0.0000);
@BND(-279415.1757,N45,0.0000);
@BND(-279415.1757,N46,0.0000);
@BND(-279415.1757,N47,0.0000);
@BND(-279415.1757,N48,0.0000);
@BND(-279415.1757,N49,0.0000);
@BND(-279415.1757,N50,0.0000);
@BND(-279415.1757,N51,0.0000);
@BND(-279415.1757,N52,0.0000);
@BND(-279415.1757,N53,0.0000);
@BND(-279415.1757,N54,0.0000);
@BND(-279415.1757,N55,0.0000);
@BND(-279415.1757,N56,0.0000);
@BND(-279415.1757,N57,0.0000);
@BND(-279415.1757,N58,0.0000);
@BND(-279415.1757,N59,0.0000);
@BND(-279415.1757,N60,0.0000);
@BND(-323210.4800,N61,125000.0000);
@BND(-279415.1757,N62,0.0000);
@BND(-323210.4800,N63,125000.0000);
@BND(-279415.1757,N64,0.0000);
@BND(-323210.4800,N65,125000.0000);
@BND(-279415.1757,N66,0.0000);
@BND(-323210.4800,N67,125000.0000);
@BND(-279415.1757,N68,0.0000);
@BND(-323210.4800,N69,125000.0000);
@BND(-279415.1757,N70,0.0000);
@BND(-323210.4800,N71,125000.0000);
@BND(-279415.1757,N72,0.0000);
@BND(-323210.4800,N73,125000.0000);
@BND(-279415.1757,N74,0.0000);
@BND(-323210.4800,N75,125000.0000);
@BND(-279415.1757,N76,0.0000);
@BND(-323210.4800,N77,125000.0000);
@BND(-279415.1757,N78,0.0000);
@BND(-323210.4800,N79,125000.0000);
@BND(-279415.1757,N80,0.0000);
@BND(-323210.4800,N81,125000.0000);
@BND(-279415.1757,N82,0.0000);
@BND(-323210.4800,N83,125000.0000);
@BND(0.0000,N84,0.0000);
@BND(-279415.1757,N85,0.0000);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N84);
@FREE(N85);

END
```

- **Resultado da Carga de Colapso:**

```
Global optimal solution found at step:           34
 Objective value:                            26159.79

              Variable           Value        Reduced Cost
                     P        26159.79         0.0000000
                    N1       -88541.67         0.0000000
                    N4       -52083.33         0.0000000
                    N5        0.0000000       -0.2952917E-01
                   N39       -51677.30         0.0000000
                    N6        36623.70         0.0000000
                    N7       -15625.00         0.0000000
                    N8       -51677.30         0.0000000
                   N40        0.0000000         0.0000000
                    N9        36623.70         0.0000000
                   N10        20833.33         0.0000000
                   N11        0.0000000         0.0000000
                   N43       -51677.30         0.0000000
                   N12        36623.70         0.0000000
                   N13        57291.67         0.0000000
                   N14       -51677.30         0.0000000
                   N44        0.0000000         0.0000000
                   N15        36623.70         0.0000000
                   N16        93750.00         0.0000000
                   N17        0.0000000         0.0000000
                   N47       -51677.30         0.0000000
                   N18        36623.70         0.0000000
                   N19        104166.7         0.0000000
                   N20       -14764.94         0.0000000
                   N48        0.0000000         0.0000000
                   N21        10463.91         0.0000000
                   N22        114583.3         0.0000000
                   N23        0.0000000         0.0000000
                   N51       -14764.94         0.0000000
                   N24        10463.91         0.0000000
                   N25        125000.0         0.0000000
                   N26       -14764.94         0.0000000
                   N52        0.0000000         0.0000000
                   N27        10463.91         0.0000000
                   N28        125000.0        -0.1674226
                   N29        0.0000000         0.0000000
                   N55        0.0000000        -0.1181167
                   N30        0.0000000         0.0000000
                   N31        83333.33         0.0000000
                   N32        0.0000000         0.0000000
                   N56       -59059.77         0.0000000
                   N33        41855.66         0.0000000
                   N34        41666.67         0.0000000
                   N35       -59059.77         0.0000000
                   N59        0.0000000         0.0000000
                   N36        41855.66         0.0000000
                   N60       -59059.77         0.0000000
                    N2       -51677.30         0.0000000
                   N37        0.0000000         0.0000000
                   N38       -51677.30         0.0000000
                   N62        0.0000000         0.0000000
                   N64       -51677.30         0.0000000
                   N41        0.0000000         0.0000000
                   N42       -51677.30         0.0000000
```

```
N66        0.0000000           0.0000000
N68       -51677.30            0.0000000
N45        0.0000000           0.0000000
N46       -51677.30            0.0000000
N70        0.0000000           0.0000000
N72       -51677.30            0.0000000
N49        0.0000000           0.0000000
N50       -14764.94            0.0000000
N74        0.0000000           0.0000000
N76       -14764.94            0.0000000
N53        0.0000000           0.0000000
N54       -14764.94            0.0000000
N78       -59059.77            0.0000000
N80        0.0000000           0.0000000
N57       -59059.77            0.0000000
N58        0.0000000           0.0000000
N82       -59059.77            0.0000000
N85        0.0000000           0.0000000
N61        125000.0           -0.4185566E-01
N63        88541.67            0.0000000
N65        52083.33            0.0000000
N67        15625.00            0.0000000
N69       -20833.33            0.0000000
N71       -57291.67            0.0000000
N73       -93750.00            0.0000000
N75       -104166.7            0.0000000
N77       -114583.3            0.0000000
N79       -83333.33            0.0000000
N81       -41666.67            0.0000000
N83        0.0000000           0.0000000
N84        0.0000000           0.0000000
 N3        0.0000000           0.0000000
```

- **Dimensionamento:**

```
DATA:
P = 18685.57;
ENDDATA

min = (A1 * 33.33 + A4 * 33.33 + A7 * 33.33 + A10 * 33.33 + A13 *
33.33 + A16 * 33.33 + A19 * 33.33 + A22 * 33.33 + A25 * 33.33 +
A28 * 33.33 + A31 * 33.33 + A34 * 33.33 + A61 * 33.33 + A63 *
33.33 + A65 * 33.33 + A67 * 33.33 + A69 * 33.33 + A71 * 33.33 +
A73 * 33.33 + A75 * 33.33 + A77 * 33.33 + A79 * 33.33 + A81 *
33.33 + A83 * 33.33 + A6 * 33.48 + A9 * 33.48 + A12 * 33.48 + A15
* 33.48 + A18 * 33.48 + A21 * 33.48 + A24 * 33.48 + A27 * 33.48 +
A30 * 33.48 + A33 * 33.48 + A36 * 33.48);

- 1.0000 * N1 + 1.0000 * N4 - 0.7055 * N5 + 0.7055 * N39 = 0 ;
+ 0.7087 * N5 + 1.0000 * N6 + 0.7087 * N39 = 0 ;
- 1.0000 * N4 + 1.0000 * N7 + 0.7055 * N8 - 0.7055 * N40 = 0 ;
+ 0.7087 * N8 + 1.0000 * N9 + 0.7087 * N40 = 0 ;
- 1.0000 * N7 + 1.0000 * N10 - 0.7055 * N11 + 0.7055 * N43 = 0 ;
+ 0.7087 * N11 + 1.0000 * N12 + 0.7087 * N43 = 0 ;
- 1.0000 * N10 + 1.0000 * N13 + 0.7055 * N14 - 0.7055 * N44 = 0 ;
+ 0.7087 * N14 + 1.0000 * N15 + 0.7087 * N44 = 0 ;
- 1.0000 * N13 + 1.0000 * N16 - 0.7055 * N17 + 0.7055 * N47 = 0 ;
+ 0.7087 * N17 + 1.0000 * N18 + 0.7087 * N47 = 0 ;
- 1.0000 * N16 + 1.0000 * N19 + 0.7055 * N20 - 0.7055 * N48 = 0 ;
+ 0.7087 * N20 + 1.0000 * N21 + 0.7087 * N48 = 0 ;
- 1.0000 * N19 + 1.0000 * N22 - 0.7055 * N23 + 0.7055 * N51 = 0 ;
+ 0.7087 * N23 + 1.0000 * N24 + 0.7087 * N51 = 0 ;
- 1.0000 * N22 + 1.0000 * N25 + 0.7055 * N26 - 0.7055 * N52 = 0 ;
+ 0.7087 * N26 + 1.0000 * N27 + 0.7087 * N52 = 0 ;
- 1.0000 * N25 + 1.0000 * N28 - 0.7055 * N29 + 0.7055 * N55 = 0 ;
+ 0.7087 * N29 + 1.0000 * N30 + 0.7087 * N55 = 0 ;
- 1.0000 * N28 + 1.0000 * N31 + 0.7055 * N32 - 0.7055 * N56 = 0 ;
+ 0.7087 * N32 + 1.0000 * N33 + 0.7087 * N56 = 0 ;
- 1.0000 * N31 + 1.0000 * N34 - 0.7055 * N35 + 0.7055 * N59 = 0 ;
+ 0.7087 * N35 + 1.0000 * N36 + 0.7087 * N59 = 0 ;
- 1.0000 * N34 - 0.7055 * N60 = 0 ;
- 0.7055 * N2 + 0.7055 * N5 - 0.7055 * N37 + 0.7055 * N38 = 0 ;
- 0.7087 * N2 - 0.7087 * N5 + 0.7087 * N37 + 0.7087 * N38 = 0 ;
- 0.7055 * N39 + 0.7055 * N40 - 0.7055 * N62 + 0.7055 * N64 = 0 ;
- 0.7087 * N39 - 0.7087 * N40 + 0.7087 * N62 + 0.7087 * N64 = 0 ;
- 0.7055 * N8 + 0.7055 * N11 - 0.7055 * N41 + 0.7055 * N42 = 0 ;
- 0.7087 * N8 - 0.7087 * N11 + 0.7087 * N41 + 0.7087 * N42 = 0 ;
- 0.7055 * N43 + 0.7055 * N44 - 0.7055 * N66 + 0.7055 * N68 = 0 ;
- 0.7087 * N43 - 0.7087 * N44 + 0.7087 * N66 + 0.7087 * N68 = 0 ;
- 0.7055 * N14 + 0.7055 * N17 - 0.7055 * N45 + 0.7055 * N46 = 0 ;
- 0.7087 * N14 - 0.7087 * N17 + 0.7087 * N45 + 0.7087 * N46 = 0 ;
- 0.7055 * N47 + 0.7055 * N48 - 0.7055 * N70 + 0.7055 * N72 = 0 ;
- 0.7087 * N47 - 0.7087 * N48 + 0.7087 * N70 + 0.7087 * N72 = 0 ;
- 0.7055 * N20 + 0.7055 * N23 - 0.7055 * N49 + 0.7055 * N50 = 0 ;
- 0.7087 * N20 - 0.7087 * N23 + 0.7087 * N49 + 0.7087 * N50 = 0 ;
- 0.7055 * N51 + 0.7055 * N52 - 0.7055 * N74 + 0.7055 * N76 = 0 ;
- 0.7087 * N51 - 0.7087 * N52 + 0.7087 * N74 + 0.7087 * N76 = 0 ;
- 0.7055 * N26 + 0.7055 * N29 - 0.7055 * N53 + 0.7055 * N54 = 0 ;
- 0.7087 * N26 - 0.7087 * N29 + 0.7087 * N53 + 0.7087 * N54 = 0 ;
- 0.7055 * N55 + 0.7055 * N56 - 0.7055 * N78 + 0.7055 * N80 = 0 ;
- 0.7087 * N55 - 0.7087 * N56 + 0.7087 * N78 + 0.7087 * N80 = 0 ;
- 0.7055 * N32 + 0.7055 * N35 - 0.7055 * N57 + 0.7055 * N58 = 0 ;
- 0.7087 * N32 - 0.7087 * N35 + 0.7087 * N57 + 0.7087 * N58 = 0 ;
```

```
- 0.7055 * N59 + 0.7055 * N60 - 0.7055 * N82 + 0.7055 * N85 = 0 ;
- 0.7087 * N59 - 0.7087 * N60 + 0.7087 * N82 + 0.7087 * N85 = 0 ;
- 0.7055 * N38 - 1.0000 * N61 + 0.7055 * N62 + 1.0000 * N63 = 0 ;
- 1.0000 * N6 - 0.7087 * N38 - 0.7087 * N62 = 0 ;
+ 0.7055 * N41 - 1.0000 * N63 - 0.7055 * N64 + 1.0000 * N65 = 0 ;
- 1.0000 * N9 - 0.7087 * N41 - 0.7087 * N64 = 0 ;
- 0.7055 * N42 - 1.0000 * N65 + 0.7055 * N66 + 1.0000 * N67 = 0 ;
- 1.0000 * N12 - 0.7087 * N42 - 0.7087 * N66 = 0 ;
+ 0.7055 * N45 - 1.0000 * N67 - 0.7055 * N68 + 1.0000 * N69 = 0 ;
- 1.0000 * N15 - 0.7087 * N45 - 0.7087 * N68 = 0 ;
- 0.7055 * N46 - 1.0000 * N69 + 0.7055 * N70 + 1.0000 * N71 = 0 ;
- 1.0000 * N18 - 0.7087 * N46 - 0.7087 * N70 = 0 ;
+ 0.7055 * N49 - 1.0000 * N71 - 0.7055 * N72 + 1.0000 * N73 = 0 ;
- 1.0000 * P - 1.0000 * N21 - 0.7087 * N49 - 0.7087 * N72 = 0 ;
- 0.7055 * N50 - 1.0000 * N73 + 0.7055 * N74 + 1.0000 * N75 = 0 ;
- 1.0000 * N24 - 0.7087 * N50 - 0.7087 * N74 = 0 ;
+ 0.7055 * N53 - 1.0000 * N75 - 0.7055 * N76 + 1.0000 * N77 = 0 ;
- 1.0000 * N27 - 0.7087 * N53 - 0.7087 * N76 = 0 ;
- 0.7055 * N54 - 1.0000 * N77 + 0.7055 * N78 + 1.0000 * N79 = 0 ;
- 2.0000 * P - 1.0000 * N30 - 0.7087 * N54 - 0.7087 * N78 = 0 ;
+ 0.7055 * N57 - 1.0000 * N79 - 0.7055 * N80 + 1.0000 * N81 = 0 ;
- 1.0000 * N33 - 0.7087 * N57 - 0.7087 * N80 = 0 ;
- 0.7055 * N58 - 1.0000 * N81 + 0.7055 * N82 + 1.0000 * N83 = 0 ;
- 1.0000 * N36 - 0.7087 * N58 - 0.7087 * N82 = 0 ;
- 1.0000 * N83 - 0.7055 * N85 = 0 ;
- 1.0000 * N84 - 0.7087 * N85 = 0 ;
N6 - 43478.26 * A6 <= 0;
N9 - 43478.26 * A9 <= 0;
N12 - 43478.26 * A12 <= 0;
N15 - 43478.26 * A15 <= 0;
N18 - 43478.26 * A18 <= 0;
N21 - 43478.26 * A21 <= 0;
N24 - 43478.26 * A24 <= 0;
N27 - 43478.26 * A27 <= 0;
N30 - 43478.26 * A30 <= 0;
N33 - 43478.26 * A33 <= 0;
N36 - 43478.26 * A36 <= 0;
N1 - 43478.26 * A1 <= 0;
141573.57 + 43478.26 * A1 + N1 >= 0;
N4 - 43478.26 * A4 <= 0;
141573.57 + 43478.26 * A4 + N4 >= 0;
N7 - 43478.26 * A7 <= 0;
141573.57 + 43478.26 * A7 + N7 >= 0;
N10 - 43478.26 * A10 <= 0;
141573.57 + 43478.26 * A10 + N10 >= 0;
N13 - 43478.26 * A13 <= 0;
141573.57 + 43478.26 * A13 + N13 >= 0;
N16 - 43478.26 * A16 <= 0;
141573.57 + 43478.26 * A16 + N16 >= 0;
N19 - 43478.26 * A19 <= 0;
141573.57 + 43478.26 * A19 + N19 >= 0;
N22 - 43478.26 * A22 <= 0;
141573.57 + 43478.26 * A22 + N22 >= 0;
N25 - 43478.26 * A25 <= 0;
141573.57 + 43478.26 * A25 + N25 >= 0;
N28 - 43478.26 * A28 <= 0;
141573.57 + 43478.26 * A28 + N28 >= 0;
N31 - 43478.26 * A31 <= 0;
141573.57 + 43478.26 * A31 + N31 >= 0;
N34 - 43478.26 * A34 <= 0;
141573.57 + 43478.26 * A34 + N34 >= 0;
```

```
N61 - 43478.26 * A61 <= 0;
141573.57 + 43478.26 * A61 + N61 >= 0;
N63 - 43478.26 * A63 <= 0;
141573.57 + 43478.26 * A63 + N63 >= 0;
N65 - 43478.26 * A65 <= 0;
141573.57 + 43478.26 * A65 + N65 >= 0;
N67 - 43478.26 * A67 <= 0;
141573.57 + 43478.26 * A67 + N67 >= 0;
N69 - 43478.26 * A69 <= 0;
141573.57 + 43478.26 * A69 + N69 >= 0;
N71 - 43478.26 * A71 <= 0;
141573.57 + 43478.26 * A71 + N71 >= 0;
N73 - 43478.26 * A73 <= 0;
141573.57 + 43478.26 * A73 + N73 >= 0;
N75 - 43478.26 * A75 <= 0;
141573.57 + 43478.26 * A75 + N75 >= 0;
N77 - 43478.26 * A77 <= 0;
141573.57 + 43478.26 * A77 + N77 >= 0;
N79 - 43478.26 * A79 <= 0;
141573.57 + 43478.26 * A79 + N79 >= 0;
N81 - 43478.26 * A81 <= 0;
141573.57 + 43478.26 * A81 + N81 >= 0;
N83 - 43478.26 * A83 <= 0;
141573.57 + 43478.26 * A83 + N83 >= 0;

@BND(-323210.4800,N1,125000.0000);
@BND(-279415.1757,N2,0.0000);
@BND(0.0000,N3,0.0000);
@BND(-323210.4800,N4,125000.0000);
@BND(-279415.1757,N5,0.0000);
@BND(0.0000,N6,123235.1500);
@BND(-323210.4800,N7,125000.0000);
@BND(-279415.1757,N8,0.0000);
@BND(0.0000,N9,123235.1500);
@BND(-323210.4800,N10,125000.0000);
@BND(-279415.1757,N11,0.0000);
@BND(0.0000,N12,123235.1500);
@BND(-323210.4800,N13,125000.0000);
@BND(-279415.1757,N14,0.0000);
@BND(0.0000,N15,123235.1500);
@BND(-323210.4800,N16,125000.0000);
@BND(-279415.1757,N17,0.0000);
@BND(0.0000,N18,123235.1500);
@BND(-323210.4800,N19,125000.0000);
@BND(-279415.1757,N20,0.0000);
@BND(0.0000,N21,123235.1500);
@BND(-323210.4800,N22,125000.0000);
@BND(-279415.1757,N23,0.0000);
@BND(0.0000,N24,123235.1500);
@BND(-323210.4800,N25,125000.0000);
@BND(-279415.1757,N26,0.0000);
@BND(0.0000,N27,123235.1500);
@BND(-323210.4800,N28,125000.0000);
@BND(-279415.1757,N29,0.0000);
@BND(0.0000,N30,123235.1500);
@BND(-323210.4800,N31,125000.0000);
@BND(-279415.1757,N32,0.0000);
@BND(0.0000,N33,123235.1500);
@BND(-323210.4800,N34,125000.0000);
@BND(-279415.1757,N35,0.0000);
@BND(0.0000,N36,123235.1500);
```

```
@BND(-279415.1757,N37,0.0000);
@BND(-279415.1757,N38,0.0000);
@BND(-279415.1757,N39,0.0000);
@BND(-279415.1757,N40,0.0000);
@BND(-279415.1757,N41,0.0000);
@BND(-279415.1757,N42,0.0000);
@BND(-279415.1757,N43,0.0000);
@BND(-279415.1757,N44,0.0000);
@BND(-279415.1757,N45,0.0000);
@BND(-279415.1757,N46,0.0000);
@BND(-279415.1757,N47,0.0000);
@BND(-279415.1757,N48,0.0000);
@BND(-279415.1757,N49,0.0000);
@BND(-279415.1757,N50,0.0000);
@BND(-279415.1757,N51,0.0000);
@BND(-279415.1757,N52,0.0000);
@BND(-279415.1757,N53,0.0000);
@BND(-279415.1757,N54,0.0000);
@BND(-279415.1757,N55,0.0000);
@BND(-279415.1757,N56,0.0000);
@BND(-279415.1757,N57,0.0000);
@BND(-279415.1757,N58,0.0000);
@BND(-279415.1757,N59,0.0000);
@BND(-279415.1757,N60,0.0000);
@BND(-323210.4800,N61,125000.0000);
@BND(-279415.1757,N62,0.0000);
@BND(-323210.4800,N63,125000.0000);
@BND(-279415.1757,N64,0.0000);
@BND(-323210.4800,N65,125000.0000);
@BND(-279415.1757,N66,0.0000);
@BND(-323210.4800,N67,125000.0000);
@BND(-279415.1757,N68,0.0000);
@BND(-323210.4800,N69,125000.0000);
@BND(-279415.1757,N70,0.0000);
@BND(-323210.4800,N71,125000.0000);
@BND(-279415.1757,N72,0.0000);
@BND(-323210.4800,N73,125000.0000);
@BND(-279415.1757,N74,0.0000);
@BND(-323210.4800,N75,125000.0000);
@BND(-279415.1757,N76,0.0000);
@BND(-323210.4800,N77,125000.0000);
@BND(-279415.1757,N78,0.0000);
@BND(-323210.4800,N79,125000.0000);
@BND(-279415.1757,N80,0.0000);
@BND(-323210.4800,N81,125000.0000);
@BND(-279415.1757,N82,0.0000);
@BND(-323210.4800,N83,125000.0000);
@BND(0.0000,N84,0.0000);
@BND(-279415.1757,N85,0.0000);
@BND(0.9,A1,24);
@BND(0.9,A4,24);
@BND(0.9,A7,24);
@BND(0.9,A10,24);
@BND(0.9,A13,24);
@BND(0.9,A16,24);
@BND(0.9,A19,24);
@BND(0.9,A22,24);
@BND(0.9,A25,24);
@BND(0.9,A28,24);
@BND(0.9,A31,24);
@BND(0.9,A34,24);
```

```
@BND(0.9,A61,24);
@BND(0.9,A63,24);
@BND(0.9,A65,24);
@BND(0.9,A67,24);
@BND(0.9,A69,24);
@BND(0.9,A71,24);
@BND(0.9,A73,24);
@BND(0.9,A75,24);
@BND(0.9,A77,24);
@BND(0.9,A79,24);
@BND(0.9,A81,24);
@BND(0.9,A83,24);
@BND(0.44,A6,20);
@BND(0.44,A9,20);
@BND(0.44,A12,20);
@BND(0.44,A15,20);
@BND(0.44,A18,20);
@BND(0.44,A21,20);
@BND(0.44,A24,20);
@BND(0.44,A27,20);
@BND(0.44,A30,20);
@BND(0.44,A33,20);
@BND(0.44,A36,20);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N84);
@FREE(N85);

END
```

- **Resultado do Dimensionamento:**

```
Global optimal solution found at step:            64
 Objective value:                             1156.991

                 Variable           Value        Reduced Cost
                     P           18685.57          0.000000
                    A1           0.9000000         33.33000
                    A4           0.9000000         33.33000
                    A7           0.9000000         33.33000
                   A10           0.9000000         33.33000
                   A13           0.9101793          0.0000000
                   A16           1.513572           0.0000000
                   A19           1.689138           0.0000000
                   A22           1.864703           0.0000000
                   A25           2.040269           0.0000000
                   A28           2.040269           0.0000000
                   A31           1.360179           0.0000000
                   A34           0.9000000         33.33000
                   A61           2.106786           0.0000000
                   A63           1.503393           0.0000000
                   A65           0.9000000         20.08856
                   A67           0.9000000         33.33000
                   A69           0.9000000         33.33000
                   A71           0.9000000         33.33000
                   A73           0.9000000         33.33000
                   A75           0.9000000         33.33000
                   A77           0.9000000         33.33000
                   A79           0.9000000         33.33000
                   A81           0.9000000         33.33000
                   A83           0.9000000         33.33000
                    A6           0.6061300          0.0000000
                    A9           0.6061300          0.0000000
                   A12           0.6061300          0.0000000
                   A15           0.6061300          0.0000000
                   A18           0.6061300          0.0000000
                   A21           0.4400000         33.48000
                   A24           0.4400000         33.48000
                   A27           0.4400000         33.48000
                   A30           0.4400000         33.48000
                   A33           0.6831744          0.0000000
                   A36           0.6831744          0.0000000
                    N1          -65364.91           0.0000000
                    N4          -39130.43           0.0000000
                    N5           0.0000000         -0.1086557E-02
                   N39         -37185.66           0.0000000
                    N6           26353.48           0.0000000
                    N7          -12895.95           0.0000000
                    N8          -37185.66           0.0000000
                   N40           0.0000000         -0.1627386E-02
                    N9           26353.48           0.0000000
                   N10           13338.53           0.0000000
                   N11           0.0000000         -0.1306317E-02
                   N43         -37185.66           0.0000000
                   N12           26353.48           0.0000000
                   N13           39573.01           0.0000000
                   N14          -37185.66           0.0000000
                   N44           0.0000000         -0.1091455E-02
                   N15           26353.48           0.0000000
                   N16           65807.49           0.0000000
```

```
N17      0.0000000        -0.1632284E-02
N47     -37185.66          0.0000000
N18      26353.48          0.0000000
N19      73440.78          0.0000000
N20     -10819.68          0.0000000
N48      0.0000000        -0.1086557E-02
N21      7667.906          0.0000000
N22      81074.06          0.0000000
N23      0.0000000        -0.5408293E-03
N51     -10819.68          0.0000000
N24      7667.906          0.0000000
N25      88707.34          0.0000000
N26     -10819.68          0.0000000
N52      0.0000000        -0.5408293E-03
N27      7667.906          0.0000000
N28      88707.34          0.0000000
N29      0.0000000        -0.5408293E-03
N55      0.0000000        -0.1086557E-02
N30      0.0000000          0.0000000
N31      59138.23          0.0000000
N32      0.0000000          0.0000000
N56     -41912.28          0.0000000
N33      29703.23          0.0000000
N34      29569.11          0.0000000
N35     -41912.28          0.0000000
N59      0.0000000        -0.5457274E-03
N36      29703.23          0.0000000
N60     -41912.28          0.0000000
 N2     -37185.66          0.0000000
N37      0.0000000          0.0000000
N38     -37185.66          0.0000000
N62      0.0000000        -0.4898103E-05
N64     -37185.66          0.0000000
N41      0.0000000          0.0000000
N42     -37185.66          0.0000000
N66      0.0000000          0.0000000
N68     -37185.66          0.0000000
N45      0.0000000          0.0000000
N46     -37185.66          0.0000000
N70      0.0000000          0.0000000
N72     -37185.66          0.0000000
N49      0.0000000          0.0000000
N50     -10819.68          0.0000000
N74      0.0000000          0.0000000
N76     -10819.68          0.0000000
N53      0.0000000          0.0000000
N54     -10819.68          0.0000000
N78     -41912.28          0.0000000
N80      0.0000000          0.0000000
N57     -41912.28          0.0000000
N58      0.0000000        -0.1632284E-02
N82     -41912.28          0.0000000
N85      0.0000000          0.0000000
N61      91599.40          0.0000000
N63      65364.91          0.0000000
N65      39130.43          0.0000000
N67      12895.95          0.0000000
N69     -13338.53          0.0000000
N71     -39573.01          0.0000000
N73     -65807.49          0.0000000
N75     -73440.78          0.0000000
```

```
N77        -81074.06            0.0000000
N79        -59138.23            0.0000000
N81        -29569.11            0.0000000
N83        0.0000000            0.0000000
N84        0.0000000            0.0000000
 N3        0.0000000            0.0000000
```

→ **EXEMPLO 5**

- **Carga de Colapso:**

```
model:

 max =P;
+ 1.0000 * N1 + 0.7048 * N23 = 0 ;
- 1.0000 * N1 + 1.0000 * N2 + 0.7048 * N3 - 0.7048 * N24 = 0 ;
+ 0.7094 * N3 + 0.7094 * N24 + 1.0000 * N47 = 0 ;
- 1.0000 * N2 + 1.0000 * N4 - 0.7048 * N5 + 0.7048 * N27 = 0 ;
+ 0.7094 * N5 + 0.7094 * N27 + 1.0000 * N50 = 0 ;
- 1.0000 * N4 + 1.0000 * N6 + 0.7048 * N7 - 0.7048 * N28 = 0 ;
+ 0.7094 * N7 + 0.7094 * N28 + 1.0000 * N53 = 0 ;
- 1.0000 * N6 + 1.0000 * N8 - 0.7048 * N9 + 0.7048 * N31 = 0 ;
+ 0.7094 * N9 + 0.7094 * N31 + 1.0000 * N56 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7048 * N11 - 0.7048 * N32 = 0 ;
+ 0.7094 * N11 + 0.7094 * N32 + 1.0000 * N59 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7048 * N13 + 0.7048 * N35 = 0 ;
+ 0.7094 * N13 + 0.7094 * N35 + 1.0000 * N62 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7048 * N15 - 0.7048 * N36 = 0 ;
+ 0.7094 * N15 + 0.7094 * N36 + 1.0000 * N65 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7048 * N17 + 0.7048 * N39 = 0 ;
+ 0.7094 * N17 + 0.7094 * N39 + 1.0000 * N68 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7048 * N19 - 0.7048 * N40 = 0 ;
+ 0.7094 * N19 + 0.7094 * N40 + 1.0000 * N71 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7048 * N21 + 0.7048 * N43 = 0 ;
+ 0.7094 * N21 + 0.7094 * N43 + 1.0000 * N74 = 0 ;
- 1.0000 * N20 - 0.7048 * N44 = 0 ;
- 0.7048 * N23 + 0.7048 * N24 - 0.7048 * N46 + 0.7048 * N48 = 0 ;
- 0.7094 * N23 - 0.7094 * N24 + 0.7094 * N46 + 0.7094 * N48 = 0 ;
- 0.7048 * N3 + 0.7048 * N5 - 0.7048 * N25 + 0.7048 * N26 = 0 ;
- 0.7094 * N3 - 0.7094 * N5 + 0.7094 * N25 + 0.7094 * N26 = 0 ;
- 0.7048 * N27 + 0.7048 * N28 - 0.7048 * N51 + 0.7048 * N54 = 0 ;
- 0.7094 * N27 - 0.7094 * N28 + 0.7094 * N51 + 0.7094 * N54 = 0 ;
- 0.7048 * N7 + 0.7048 * N9 - 0.7048 * N29 + 0.7048 * N30 = 0 ;
- 0.7094 * N7 - 0.7094 * N9 + 0.7094 * N29 + 0.7094 * N30 = 0 ;
- 0.7048 * N31 + 0.7048 * N32 - 0.7048 * N57 + 0.7048 * N60 = 0 ;
- 0.7094 * N31 - 0.7094 * N32 + 0.7094 * N57 + 0.7094 * N60 = 0 ;
- 0.7048 * N11 + 0.7048 * N13 - 0.7048 * N33 + 0.7048 * N34 = 0 ;
- 0.7094 * N11 - 0.7094 * N13 + 0.7094 * N33 + 0.7094 * N34 = 0 ;
- 0.7048 * N35 + 0.7048 * N36 - 0.7048 * N63 + 0.7048 * N66 = 0 ;
- 0.7094 * N35 - 0.7094 * N36 + 0.7094 * N63 + 0.7094 * N66 = 0 ;
- 0.7048 * N15 + 0.7048 * N17 - 0.7048 * N37 + 0.7048 * N38 = 0 ;
- 0.7094 * N15 - 0.7094 * N17 + 0.7094 * N37 + 0.7094 * N38 = 0 ;
- 0.7048 * N39 + 0.7048 * N40 - 0.7048 * N69 + 0.7048 * N72 = 0 ;
- 0.7094 * N39 - 0.7094 * N40 + 0.7094 * N69 + 0.7094 * N72 = 0 ;
- 0.7048 * N19 + 0.7048 * N21 - 0.7048 * N41 + 0.7048 * N42 = 0 ;
- 0.7094 * N19 - 0.7094 * N21 + 0.7094 * N41 + 0.7094 * N42 = 0 ;
- 0.7048 * N43 + 0.7048 * N44 - 0.7048 * N75 + 0.7048 * N77 = 0 ;
- 0.7094 * N43 - 0.7094 * N44 + 0.7094 * N75 + 0.7094 * N77 = 0 ;
+ 0.7048 * N46 + 1.0000 * N49 = 0 ;
- 3400.0000 * P - 200 - 1.0000 * N45 - 0.7094 * N46 = 0 ;
+ 0.7048 * N25 - 0.7048 * N48 - 1.0000 * N49 + 1.0000 * N52 = 0 ;
- 6810 * P - 400 - 0.7094 * N25 - 1.0000 * N47 - 0.7094 * N48 = 0;
- 0.7048 * N26 + 0.7048 * N51 - 1.0000 * N52 + 1.0000 * N55 = 0 ;
- 6810 * P - 400 - 0.7094 * N26 - 1.0000 * N50 - 0.7094 * N51 = 0;
+ 0.7048 * N29 - 0.7048 * N54 - 1.0000 * N55 + 1.0000 * N58 = 0 ;
```

```
- 6810 * P - 400 - 0.7094 * N29 - 1.0000 * N53 - 0.7094 * N54 = 0;
- 0.7048 * N30 + 0.7048 * N57 - 1.0000 * N58 + 1.0000 * N61 = 0 ;
- 6810 * P - 400 - 0.7094 * N30 - 1.0000 * N56 - 0.7094 * N57 = 0;
+ 0.7048 * N33 - 0.7048 * N60 - 1.0000 * N61 + 1.0000 * N64 = 0 ;
- 6810 * P - 400 - 0.7094 * N33 - 1.0000 * N59 - 0.7094 * N60 = 0;
- 0.7048 * N34 + 0.7048 * N63 - 1.0000 * N64 + 1.0000 * N67 = 0 ;
- 6810 * P - 400 - 0.7094 * N34 - 1.0000 * N62 - 0.7094 * N63 = 0;
+ 0.7048 * N37 - 0.7048 * N66 - 1.0000 * N67 + 1.0000 * N70 = 0 ;
- 6810 * P - 400 - 0.7094 * N37 - 1.0000 * N65 - 0.7094 * N66 = 0;
- 0.7048 * N38 + 0.7048 * N69 - 1.0000 * N70 + 1.0000 * N73 = 0 ;
- 6810 * P - 400 - 0.7094 * N38 - 1.0000 * N68 - 0.7094 * N69 = 0;
+ 0.7048 * N41 - 0.7048 * N72 - 1.0000 * N73 + 1.0000 * N76 = 0 ;
- 6810 * P - 400 - 0.7094 * N41 - 1.0000 * N71 - 0.7094 * N72 = 0;
- 0.7048 * N42 + 0.7048 * N75 - 1.0000 * N76 + 1.0000 * N78 = 0 ;
- 6810 * P - 400 - 0.7094 * N42 - 1.0000 * N74 - 0.7094 * N75 = 0;
- 0.7048 * N77 - 1.0000 * N78 = 0 ;
- 3400 * P - 200 - 1.0000 * N22 - 0.7094 * N77 = 0 ;

@BND(-366953.2000,N1,250000.0000);
@BND(-366953.2000,N2,250000.0000);
@BND(-168327.2221,N3,0.0000);
@BND(-366953.2000,N4,250000.0000);
@BND(-168327.2221,N5,0.0000);
@BND(-366953.2000,N6,250000.0000);
@BND(-168327.2221,N7,0.0000);
@BND(-366953.2000,N8,250000.0000);
@BND(-168327.2221,N9,0.0000);
@BND(-366953.2000,N10,250000.0000);
@BND(-168327.2221,N11,0.0000);
@BND(-366953.2000,N12,250000.0000);
@BND(-168327.2221,N13,0.0000);
@BND(-366953.2000,N14,250000.0000);
@BND(-168327.2221,N15,0.0000);
@BND(-366953.2000,N16,250000.0000);
@BND(-168327.2221,N17,0.0000);
@BND(-366953.2000,N18,250000.0000);
@BND(-168327.2221,N19,0.0000);
@BND(-366953.2000,N20,250000.0000);
@BND(-168327.2221,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-168327.2221,N23,0.0000);
@BND(-168327.2221,N24,0.0000);
@BND(-168327.2221,N25,0.0000);
@BND(-168327.2221,N26,0.0000);
@BND(-168327.2221,N27,0.0000);
@BND(-168327.2221,N28,0.0000);
@BND(-168327.2221,N29,0.0000);
@BND(-168327.2221,N30,0.0000);
@BND(-168327.2221,N31,0.0000);
@BND(-168327.2221,N32,0.0000);
@BND(-168327.2221,N33,0.0000);
@BND(-168327.2221,N34,0.0000);
@BND(-168327.2221,N35,0.0000);
@BND(-168327.2221,N36,0.0000);
@BND(-168327.2221,N37,0.0000);
@BND(-168327.2221,N38,0.0000);
@BND(-168327.2221,N39,0.0000);
@BND(-168327.2221,N40,0.0000);
@BND(-168327.2221,N41,0.0000);
@BND(-168327.2221,N42,0.0000);
@BND(-168327.2221,N43,0.0000);
```

```
@BND(-168327.2221,N44,0.0000);
@BND(0.0000,N45,0.0000);
@BND(-168327.2221,N46,0.0000);
@BND(0.0000,N47,61836.0000);
@BND(-168327.2221,N48,0.0000);
@BND(-136953.2000,N49,20000.0000);
@BND(0.0000,N50,61836.0000);
@BND(-168327.2221,N51,0.0000);
@BND(-136953.2000,N52,20000.0000);
@BND(0.0000,N53,61836.0000);
@BND(-168327.2221,N54,0.0000);
@BND(-136953.2000,N55,20000.0000);
@BND(0.0000,N56,61836.0000);
@BND(-168327.2221,N57,0.0000);
@BND(-136953.2000,N58,20000.0000);
@BND(0.0000,N59,61836.0000);
@BND(-168327.2221,N60,0.0000);
@BND(-136953.2000,N61,20000.0000);
@BND(0.0000,N62,61836.0000);
@BND(-168327.2221,N63,0.0000);
@BND(-136953.2000,N64,20000.0000);
@BND(0.0000,N65,61836.0000);
@BND(-168327.2221,N66,0.0000);
@BND(-136953.2000,N67,20000.0000);
@BND(0.0000,N68,61836.0000);
@BND(-168327.2221,N69,0.0000);
@BND(-136953.2000,N70,20000.0000);
@BND(0.0000,N71,61836.0000);
@BND(-168327.2221,N72,0.0000);
@BND(-136953.2000,N73,20000.0000);
@BND(0.0000,N74,61836.0000);
@BND(-168327.2221,N75,0.0000);
@BND(-136953.2000,N76,20000.0000);
@BND(-168327.2221,N77,0.0000);
@BND(-136953.2000,N78,20000.0000);

@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N77);
@FREE(N78);

END
```

- **Resultado da Carga de Colapso:**

```
Global optimal solution found at step:              29
 Objective value:                           1.650363

                Variable           Value        Reduced Cost
                     P          1.650363        0.0000000
                    N1          63591.04        0.0000000
                   N23         -90225.65        0.0000000
                    N2          104071.5        0.0000000
                    N3         -65627.12        0.0000000
                   N24         -8191.757        0.0000000
                   N47          52367.11        0.0000000
                    N4          138762.0        0.0000000
                    N5         0.0000000        0.0000000
                   N27         -49220.34        0.0000000
                   N50          34916.91        0.0000000
                    N6          163697.7        0.0000000
                    N7         -35379.92        0.0000000
                   N28         0.0000000        0.0000000
                   N53          25098.52        0.0000000
                    N8          198388.2        0.0000000
                    N9         -2566.362        0.0000000
                   N31         -51786.70        0.0000000
                   N56          38558.06        0.0000000
                   N10          209951.7        0.0000000
                   N11         -51786.70        0.0000000
                   N32         -35379.92        0.0000000
                   N59          61836.00      -0.5063548E-05
                   N12          198388.2        0.0000000
                   N13         -51786.70        0.0000000
                   N35         -35379.92        0.0000000
                   N62          61836.00        0.0000000
                   N14          163697.7        0.0000000
                   N15         -2566.362        0.0000000
                   N36         -51786.70        0.0000000
                   N65          38558.06        0.0000000
                   N16          138762.0        0.0000000
                   N17         -35379.92        0.0000000
                   N39         0.0000000        0.0000000
                   N68          25098.52        0.0000000
                   N18          104071.5        0.0000000
                   N19         0.0000000        0.0000000
                   N40         -49220.34        0.0000000
                   N71          34916.91        0.0000000
                   N20          63591.04        0.0000000
                   N21         -65627.12        0.0000000
                   N43         -8191.757        0.0000000
                   N74          52367.11        0.0000000
                   N44         -90225.65        0.0000000
                   N46         -8191.757        0.0000000
                   N48         -90225.65        0.0000000
                   N25         0.0000000        0.0000000
                   N26         -65627.12        0.0000000
                   N51         0.0000000        0.0000000
                   N54         -49220.34        0.0000000
                   N29         -2566.362        0.0000000
                   N30         -35379.92        0.0000000
                   N57         -35379.92        0.0000000
                   N60         -51786.70        0.0000000
```

```
N33        -51786.70           0.0000000
N34        -51786.70           0.0000000
N63        -51786.70           0.0000000
N66        -35379.92           0.0000000
N37        -35379.92           0.0000000
N38        -2566.362           0.0000000
N69        -49220.34           0.0000000
N72        0.0000000           0.0000000
N41        -65627.12           0.0000000
N42        0.0000000           0.0000000
N75        -90225.65           0.0000000
N77        -8191.757           0.0000000
N49         5773.551           0.0000000
N45        0.0000000           0.0000000
N52        -57817.49           0.0000000
N55        -104071.5           0.0000000
N58        -136953.2           0.0000000
N61        -136953.2           0.5096596E-05
N64        -136953.2           0.5096596E-05
N67        -136953.2           0.0000000
N70        -136953.2           0.0000000
N73        -104071.5           0.0000000
N76        -57817.49           0.0000000
N78         5773.551           0.0000000
N22        0.0000000           0.0000000
```

- **Dimensionamento:**

```
DATA:
P = 1.18;
ENDDATA

min = (A1 * 32.73 + A2 * 32.73 + A4 * 32.73 + A6 * 32.73 + A8 *
32.73 + A10 * 32.73 + A12 * 32.73 + A14 * 32.73 + A16 * 32.73 +
A18 * 32.73 + A20 * 32.73 + A49 * 32.73 + A52 * 32.73 + A55 *
32.73 + A58 * 32.73 + A61 * 32.73 + A64 * 32.73 + A67 * 32.73 +
A70 * 32.73 + A73 * 32.73 + A76 * 32.73 + A78 * 32.73 + A47 *
32.93 + A50 * 32.93 + A53 * 32.93 + A56 * 32.93 + A59 * 32.93 +
A62 * 32.93 + A65 * 32.93 + A68 * 32.93 + A71 * 32.93 + A74 *
32.93);

+ 1.0000 * N1 + 0.7048 * N23 = 0 ;
- 1.0000 * N1 + 1.0000 * N2 + 0.7048 * N3 - 0.7048 * N24 = 0 ;
+ 0.7094 * N3 + 0.7094 * N24 + 1.0000 * N47 = 0 ;
- 1.0000 * N2 + 1.0000 * N4 - 0.7048 * N5 + 0.7048 * N27 = 0 ;
+ 0.7094 * N5 + 0.7094 * N27 + 1.0000 * N50 = 0 ;
- 1.0000 * N4 + 1.0000 * N6 + 0.7048 * N7 - 0.7048 * N28 = 0 ;
+ 0.7094 * N7 + 0.7094 * N28 + 1.0000 * N53 = 0 ;
- 1.0000 * N6 + 1.0000 * N8 - 0.7048 * N9 + 0.7048 * N31 = 0 ;
+ 0.7094 * N9 + 0.7094 * N31 + 1.0000 * N56 = 0 ;
- 1.0000 * N8 + 1.0000 * N10 + 0.7048 * N11 - 0.7048 * N32 = 0 ;
+ 0.7094 * N11 + 0.7094 * N32 + 1.0000 * N59 = 0 ;
- 1.0000 * N10 + 1.0000 * N12 - 0.7048 * N13 + 0.7048 * N35 = 0 ;
+ 0.7094 * N13 + 0.7094 * N35 + 1.0000 * N62 = 0 ;
- 1.0000 * N12 + 1.0000 * N14 + 0.7048 * N15 - 0.7048 * N36 = 0 ;
+ 0.7094 * N15 + 0.7094 * N36 + 1.0000 * N65 = 0 ;
- 1.0000 * N14 + 1.0000 * N16 - 0.7048 * N17 + 0.7048 * N39 = 0 ;
+ 0.7094 * N17 + 0.7094 * N39 + 1.0000 * N68 = 0 ;
- 1.0000 * N16 + 1.0000 * N18 + 0.7048 * N19 - 0.7048 * N40 = 0 ;
+ 0.7094 * N19 + 0.7094 * N40 + 1.0000 * N71 = 0 ;
- 1.0000 * N18 + 1.0000 * N20 - 0.7048 * N21 + 0.7048 * N43 = 0 ;
+ 0.7094 * N21 + 0.7094 * N43 + 1.0000 * N74 = 0 ;
- 1.0000 * N20 - 0.7048 * N44 = 0 ;
- 0.7048 * N23 + 0.7048 * N24 - 0.7048 * N46 + 0.7048 * N48 = 0 ;
- 0.7094 * N23 - 0.7094 * N24 + 0.7094 * N46 + 0.7094 * N48 = 0 ;
- 0.7048 * N3 + 0.7048 * N5 - 0.7048 * N25 + 0.7048 * N26 = 0 ;
- 0.7094 * N3 - 0.7094 * N5 + 0.7094 * N25 + 0.7094 * N26 = 0 ;
- 0.7048 * N27 + 0.7048 * N28 - 0.7048 * N51 + 0.7048 * N54 = 0 ;
- 0.7094 * N27 - 0.7094 * N28 + 0.7094 * N51 + 0.7094 * N54 = 0 ;
- 0.7048 * N7 + 0.7048 * N9 - 0.7048 * N29 + 0.7048 * N30 = 0 ;
- 0.7094 * N7 - 0.7094 * N9 + 0.7094 * N29 + 0.7094 * N30 = 0 ;
- 0.7048 * N31 + 0.7048 * N32 - 0.7048 * N57 + 0.7048 * N60 = 0 ;
- 0.7094 * N31 - 0.7094 * N32 + 0.7094 * N57 + 0.7094 * N60 = 0 ;
- 0.7048 * N11 + 0.7048 * N13 - 0.7048 * N33 + 0.7048 * N34 = 0 ;
- 0.7094 * N11 - 0.7094 * N13 + 0.7094 * N33 + 0.7094 * N34 = 0 ;
- 0.7048 * N35 + 0.7048 * N36 - 0.7048 * N63 + 0.7048 * N66 = 0 ;
- 0.7094 * N35 - 0.7094 * N36 + 0.7094 * N63 + 0.7094 * N66 = 0 ;
- 0.7048 * N15 + 0.7048 * N17 - 0.7048 * N37 + 0.7048 * N38 = 0 ;
- 0.7094 * N15 - 0.7094 * N17 + 0.7094 * N37 + 0.7094 * N38 = 0 ;
- 0.7048 * N39 + 0.7048 * N40 - 0.7048 * N69 + 0.7048 * N72 = 0 ;
- 0.7094 * N39 - 0.7094 * N40 + 0.7094 * N69 + 0.7094 * N72 = 0 ;
- 0.7048 * N19 + 0.7048 * N21 - 0.7048 * N41 + 0.7048 * N42 = 0 ;
- 0.7094 * N19 - 0.7094 * N21 + 0.7094 * N41 + 0.7094 * N42 = 0 ;
- 0.7048 * N43 + 0.7048 * N44 - 0.7048 * N75 + 0.7048 * N77 = 0 ;
- 0.7094 * N43 - 0.7094 * N44 + 0.7094 * N75 + 0.7094 * N77 = 0 ;
+ 0.7048 * N46 + 1.0000 * N49 = 0 ;
```

```
- 3400 * P - 200 - 1.0000 * N45 - 0.7094 * N46 = 0 ;
+ 0.7048 * N25 - 0.7048 * N48 - 1.0000 * N49 + 1.0000 * N52 = 0 ;
- 6810 * P - 400 - 0.7094 * N25 - 1.0000 * N47 - 0.7094 * N48 = 0;
- 0.7048 * N26 + 0.7048 * N51 - 1.0000 * N52 + 1.0000 * N55 = 0 ;
- 6810 * P - 400 - 0.7094 * N26 - 1.0000 * N50 - 0.7094 * N51 = 0;
+ 0.7048 * N29 - 0.7048 * N54 - 1.0000 * N55 + 1.0000 * N58 = 0 ;
- 6810 * P - 400 - 0.7094 * N29 - 1.0000 * N53 - 0.7094 * N54 = 0;
- 0.7048 * N30 + 0.7048 * N57 - 1.0000 * N58 + 1.0000 * N61 = 0 ;
- 6810 * P - 400 - 0.7094 * N30 - 1.0000 * N56 - 0.7094 * N57 = 0;
+ 0.7048 * N33 - 0.7048 * N60 - 1.0000 * N61 + 1.0000 * N64 = 0 ;
- 6810 * P - 400 - 0.7094 * N33 - 1.0000 * N59 - 0.7094 * N60 = 0;
- 0.7048 * N34 + 0.7048 * N63 - 1.0000 * N64 + 1.0000 * N67 = 0 ;
- 6810 * P - 400 - 0.7094 * N34 - 1.0000 * N62 - 0.7094 * N63 = 0;
+ 0.7048 * N37 - 0.7048 * N66 - 1.0000 * N67 + 1.0000 * N70 = 0 ;
- 6810 * P - 400 - 0.7094 * N37 - 1.0000 * N65 - 0.7094 * N66 = 0;
- 0.7048 * N38 + 0.7048 * N69 - 1.0000 * N70 + 1.0000 * N73 = 0 ;
- 6810 * P - 400 - 0.7094 * N38 - 1.0000 * N68 - 0.7094 * N69 = 0;
+ 0.7048 * N41 - 0.7048 * N72 - 1.0000 * N73 + 1.0000 * N76 = 0 ;
- 6810 * P - 400 - 0.7094 * N41 - 1.0000 * N71 - 0.7094 * N72 = 0;
- 0.7048 * N42 + 0.7048 * N75 - 1.0000 * N76 + 1.0000 * N78 = 0 ;
- 6810 * P - 400 - 0.7094 * N42 - 1.0000 * N74 - 0.7094 * N75 = 0;
- 0.7048 * N77 - 1.0000 * N78 = 0 ;
- 3400 * P - 200 - 1.0000 * N22 - 0.7094 * N77 = 0 ;
N47 - 43478 * A47 <= 0 ;
N50 - 43478 * A50 <= 0 ;
N53 - 43478 * A53 <= 0 ;
N56 - 43478 * A56 <= 0 ;
N59 - 43478 * A59 <= 0 ;
N62 - 43478 * A62 <= 0 ;
N65 - 43478 * A65 <= 0 ;
N68 - 43478 * A68 <= 0 ;
N71 - 43478 * A71 <= 0 ;
N74 - 43478 * A74 <= 0 ;
N1 - 43478 * A1 <= 0 ;
104477.14 + 43478 * A1 + N1 >= 0 ;
N2 - 43478 * A2 <= 0 ;
104477.14 + 43478 * A2 + N2 >= 0 ;
N4 - 43478 * A4 <= 0 ;
104477.14 + 43478 * A4 + N4 >= 0 ;
N6 - 43478 * A6 <= 0 ;
104477.14 + 43478 * A6 + N6 >= 0 ;
N8 - 43478 * A8 <= 0 ;
104477.14 + 43478 * A8 + N8 >= 0 ;
N10 - 43478 * A10 <= 0 ;
104477.14 + 434.78 * A10 + N10 >= 0 ;
N12 - 43478 * A12 <= 0 ;
104477.14 + 43478 * A12 + N12 >= 0 ;
N14 - 43478 * A14 <= 0 ;
104477.14 + 43478 * A14 + N14 >= 0 ;
N16 - 43478 * A16 <= 0 ;
104477.14 + 43478 * A16 + N16 >= 0 ;
N18 - 43478 * A18 <= 0 ;
104477.14 + 43478 * A18 + N18 >= 0 ;
N20 - 43478 * A20 <= 0 ;
104477.14 + 43478 * A20 + N20 >= 0 ;
N49 - 43478 * A49 <= 0 ;
104477.14 + 43478 * A49 + N49 >= 0 ;
N52 - 43478 * A52 <= 0 ;
104477.14 + 43478 * A52 + N52 >= 0 ;
N55 - 43478 * A55 <= 0 ;
104477.14 + 43478 * A55 + N55 >= 0 ;
```

```
N58 - 43478 * A58 <= 0 ;
104477.14 + 43478 * A58 + N58 >= 0 ;
N61 - 43478 * A61 <= 0 ;
104477.14 + 43478 * A61 + N61 >= 0 ;
N64 - 43478 * A64 <= 0 ;
104477.14 + 43478 * A64 + N64 >= 0 ;
N67 - 43478 * A67 <= 0 ;
104477.14 + 43478 * A67 + N67 >= 0 ;
N70 - 43478 * A70 <= 0 ;
104477.14 + 43478 * A70 + N70 >= 0 ;
N73 - 43478 * A73 <= 0 ;
104477.14 + 43478 * A73 + N73 >= 0 ;
N76 - 43478 * A76 <= 0 ;
104477.14 + 43478 * A76 + N76 >= 0 ;
N78 - 43478 * A78 <= 0 ;
104477.14 + 43478 * A78 + N78 >= 0 ;

@BND(-366953.2000,N1,250000.0000);
@BND(-366953.2000,N2,250000.0000);
@BND(-168327.2221,N3,0.0000);
@BND(-366953.2000,N4,250000.0000);
@BND(-168327.2221,N5,0.0000);
@BND(-366953.2000,N6,250000.0000);
@BND(-168327.2221,N7,0.0000);
@BND(-366953.2000,N8,250000.0000);
@BND(-168327.2221,N9,0.0000);
@BND(-366953.2000,N10,250000.0000);
@BND(-168327.2221,N11,0.0000);
@BND(-366953.2000,N12,250000.0000);
@BND(-168327.2221,N13,0.0000);
@BND(-366953.2000,N14,250000.0000);
@BND(-168327.2221,N15,0.0000);
@BND(-366953.2000,N16,250000.0000);
@BND(-168327.2221,N17,0.0000);
@BND(-366953.2000,N18,250000.0000);
@BND(-168327.2221,N19,0.0000);
@BND(-366953.2000,N20,250000.0000);
@BND(-168327.2221,N21,0.0000);
@BND(0.0000,N22,0.0000);
@BND(-168327.2221,N23,0.0000);
@BND(-168327.2221,N24,0.0000);
@BND(-168327.2221,N25,0.0000);
@BND(-168327.2221,N26,0.0000);
@BND(-168327.2221,N27,0.0000);
@BND(-168327.2221,N28,0.0000);
@BND(-168327.2221,N29,0.0000);
@BND(-168327.2221,N30,0.0000);
@BND(-168327.2221,N31,0.0000);
@BND(-168327.2221,N32,0.0000);
@BND(-168327.2221,N33,0.0000);
@BND(-168327.2221,N34,0.0000);
@BND(-168327.2221,N35,0.0000);
@BND(-168327.2221,N36,0.0000);
@BND(-168327.2221,N37,0.0000);
@BND(-168327.2221,N38,0.0000);
@BND(-168327.2221,N39,0.0000);
@BND(-168327.2221,N40,0.0000);
@BND(-168327.2221,N41,0.0000);
@BND(-168327.2221,N42,0.0000);
@BND(-168327.2221,N43,0.0000);
@BND(-168327.2221,N44,0.0000);
```

```
@BND(0.0000,N45,0.0000);
@BND(-168327.2221,N46,0.0000);
@BND(0.0000,N47,61836.0000);
@BND(-168327.2221,N48,0.0000);
@BND(-136953.2000,N49,20000.0000);
@BND(0.0000,N50,61836.0000);
@BND(-168327.2221,N51,0.0000);
@BND(-136953.2000,N52,20000.0000);
@BND(0.0000,N53,61836.0000);
@BND(-168327.2221,N54,0.0000);
@BND(-136953.2000,N55,20000.0000);
@BND(0.0000,N56,61836.0000);
@BND(-168327.2221,N57,0.0000);
@BND(-136953.2000,N58,20000.0000);
@BND(0.0000,N59,61836.0000);
@BND(-168327.2221,N60,0.0000);
@BND(-136953.2000,N61,20000.0000);
@BND(0.0000,N62,61836.0000);
@BND(-168327.2221,N63,0.0000);
@BND(-136953.2000,N64,20000.0000);
@BND(0.0000,N65,61836.0000);
@BND(-168327.2221,N66,0.0000);
@BND(-136953.2000,N67,20000.0000);
@BND(0.0000,N68,61836.0000);
@BND(-168327.2221,N69,0.0000);
@BND(-136953.2000,N70,20000.0000);
@BND(0.0000,N71,61836.0000);
@BND(-168327.2221,N72,0.0000);
@BND(-136953.2000,N73,20000.0000);
@BND(0.0000,N74,61836.0000);
@BND(-168327.2221,N75,0.0000);
@BND(-136953.2000,N76,20000.0000);
@BND(-168327.2221,N77,0.0000);
@BND(-136953.2000,N78,20000.0000);
@BND(0.72,A1,19.2);
@BND(0.72,A2,19.2);
@BND(0.72,A4,19.2);
@BND(0.72,A6,19.2);
@BND(0.72,A8,19.2);
@BND(0.72,A10,19.2);
@BND(0.72,A12,19.2);
@BND(0.72,A14,19.2);
@BND(0.72,A16,19.2);
@BND(0.72,A18,19.2);
@BND(0.72,A20,19.2);
@BND(0.72,A49,19.2);
@BND(0.72,A52,19.2);
@BND(0.72,A55,19.2);
@BND(0.72,A58,19.2);
@BND(0.72,A61,19.2);
@BND(0.72,A64,19.2);
@BND(0.72,A67,19.2);
@BND(0.72,A70,19.2);
@BND(0.72,A73,19.2);
@BND(0.72,A76,19.2);
@BND(0.72,A78,19.2);
@BND(0.29,A47,15.71);
@BND(0.29,A50,15.71);
@BND(0.29,A53,15.71);
@BND(0.29,A56,15.71);
@BND(0.29,A59,15.71);
```

```
@BND(0.29,A62,15.71);
@BND(0.29,A65,15.71);
@BND(0.29,A68,15.71);
@BND(0.29,A71,15.71);
@BND(0.29,A74,15.71);


@FREE(N1);
@FREE(N2);
...
...
...
@FREE(N77);
@FREE(N78);

END
```

• **Resultado do Dimensionamento:**

```
Global optimal solution found at step:              77
 Objective value:                               1213.763

                Variable           Value        Reduced Cost
                   P            1.180000          0.0000000
                   A1           1.060081          0.0000000
                   A2           1.734898          0.0000000
                   A4           2.313197          0.0000000
                   A6           2.698730          0.0000000
                   A8           2.891497          0.0000000
                   A10          2.891497          0.0000000
                   A12          2.891497          0.0000000
                   A14          2.698730          0.0000000
                   A16          2.313197          0.0000000
                   A18          1.734898          0.0000000
                   A20          1.060081          0.0000000
                   A49          0.7200000          32.73000
                   A52          0.7200000          32.73000
                   A55          0.7200000          32.73000
                   A58          0.7200000          32.73000
                   A61          0.7200000          32.73000
                   A64          0.7200000          32.73000
                   A67          0.7200000          32.73000
                   A70          0.7200000          32.73000
                   A73          0.7200000          32.73000
                   A76          0.7200000          32.73000
                   A78          0.7200000          32.73000
                   A47          0.8729748          0.0000000
                   A50          0.5820737          0.0000000
                   A53          0.3880491          0.0000000
                   A56          0.2900000          32.93000
                   A59          0.2900000          32.93000
                   A62          0.2900000          32.93000
                   A65          0.2900000          32.93000
                   A68          0.3880491          0.0000000
                   A71          0.5820737          0.0000000
                   A74          0.8729748          0.0000000
                   N1           46090.18          0.0000000
                   N23         -65394.70          0.0000000
                   N2           75429.89          0.0000000
                   N3          -47565.83          0.0000000
                   N24         -5937.412          0.0000000
                   N47          37955.20          0.0000000
                   N4           100573.2          0.0000000
                   N5           0.0000000          0.0000000
                   N27         -35674.37          0.0000000
                   N50          25307.40          0.0000000
                   N6           117335.4          0.0000000
                   N7          -23782.92          0.0000000
                   N28          0.0000000          0.0000000
                   N53          16871.60          0.0000000
                   N8           125716.5          0.0000000
                   N9           0.0000000          0.0000000
                   N31         -11891.46          0.0000000
                   N56          8435.800          0.0000000
                   N10          125716.5          0.0000000
                   N11          0.0000000          0.0000000
                   N32          0.0000000          0.0000000
                   N59          0.0000000          0.0000000
```

N12	125716.5	0.0000000
N13	0.0000000	0.0000000
N35	0.0000000	0.0000000
N62	0.0000000	0.0000000
N14	117335.4	0.0000000
N15	0.0000000	-0.1067865E-02
N36	-11891.46	0.0000000
N65	8435.800	0.0000000
N16	100573.2	0.0000000
N17	-23782.92	0.0000000
N39	0.0000000	0.0000000
N68	16871.60	0.0000000
N18	75429.89	0.0000000
N19	0.0000000	-0.1605161E-02
N40	-35674.37	0.0000000
N71	25307.40	0.0000000
N20	46090.18	0.0000000
N21	-47565.83	0.0000000
N43	-5937.412	0.0000000
N74	37955.20	0.0000000
N44	-65394.70	0.0000000
N46	-5937.412	0.0000000
N48	-65394.70	0.0000000
N25	0.0000000	-0.1605161E-02
N26	-47565.83	0.0000000
N51	0.0000000	-0.1605161E-02
N54	-35674.37	0.0000000
N29	0.0000000	-0.1067865E-02
N30	-23782.92	0.0000000
N57	0.0000000	-0.5305696E-03
N60	-11891.46	0.0000000
N33	0.0000000	0.0000000
N34	0.0000000	-0.5305696E-03
N63	-11891.46	0.0000000
N66	0.0000000	-0.5305696E-03
N37	-23782.92	0.0000000
N38	0.0000000	0.0000000
N69	-35674.37	0.0000000
N72	0.0000000	-0.1605161E-02
N41	-47565.83	0.0000000
N42	0.0000000	0.0000000
N75	-65394.70	0.0000000
N77	-5937.412	0.0000000
N49	4184.688	0.0000000
N45	0.0000000	0.1505308E-02
N52	-41905.50	0.0000000
N55	-75429.89	0.0000000
N58	-100573.2	0.0000000
N61	-117335.4	0.0000000
N64	-125716.5	0.0000000
N67	-117335.4	0.0000000
N70	-100573.2	0.0000000
N73	-75429.89	0.0000000
N76	-41905.50	0.0000000
N78	4184.688	0.0000000
N22	0.0000000	0.1505308E-02