```
Clear[α, β, F1, F2, A1, A2, A3, L1, L, L3, Ym, Sh]

Sa = Sin[α]
Ca = Cos[α]

Sb = Sin[β]
Cb = Cos[β]

GT = {{-Ca, -Sa}, {-1, 0}, {-Cb, Sb}}
G = Transpose[GT]

q = {F1, F2}

L1 = L / Ca
L3 = L / Cb
F = DiagonalMatrix[{L1 / Ym / A1, L / Ym / A2, L3 / Ym / A3}]

K = Simplify[G.Inverse[F].GT]
```

$$\text{Sin}[\alpha]$$

$$\text{Cos}[\alpha]$$

$$\text{Sin}[\beta]$$

$$\text{Cos}[\beta]$$

$$\{\{-\text{Cos}[\alpha], -\text{Sin}[\alpha]\}, \{-1, 0\}, \{-\text{Cos}[\beta], \text{Sin}[\beta]\}\}$$

$$\{\{-\text{Cos}[\alpha], -1, -\text{Cos}[\beta]\}, \{-\text{Sin}[\alpha], 0, \text{Sin}[\beta]\}\}$$

$$\{F1, F2\}$$

$$L\,\text{Sec}[\alpha]$$

$$L\,\text{Sec}[\beta]$$

$$\left\{\left\{\frac{L\,\text{Sec}[\alpha]}{A1\,Ym}, 0, 0\right\}, \left\{0, \frac{L}{A2\,Ym}, 0\right\}, \left\{0, 0, \frac{L\,\text{Sec}[\beta]}{A3\,Ym}\right\}\right\}$$

$$\left\{\left\{\frac{Ym\left(A2 + A1\,\text{Cos}[\alpha]^3 + A3\,\text{Cos}[\beta]^3\right)}{L}, \frac{Ym\left(A1\,\text{Cos}[\alpha]^2\,\text{Sin}[\alpha] - A3\,\text{Cos}[\beta]^2\,\text{Sin}[\beta]\right)}{L}\right\},\right.$$
$$\left.\left\{\frac{Ym\left(A1\,\text{Cos}[\alpha]^2\,\text{Sin}[\alpha] - A3\,\text{Cos}[\beta]^2\,\text{Sin}[\beta]\right)}{L}, \frac{Ym\left(A1\,\text{Cos}[\alpha]\,\text{Sin}[\alpha]^2 + A3\,\text{Cos}[\beta]\,\text{Sin}[\beta]^2\right)}{L}\right\}\right\}$$

```
v = Simplify[Inverse[K].q]
```

$$\left\{\left(L\left(-A1\,F2\,\text{Cos}[\alpha]^2\,\text{Sin}[\alpha] + A1\,F1\,\text{Cos}[\alpha]\,\text{Sin}[\alpha]^2 + A3\,\text{Cos}[\beta]\,\text{Sin}[\beta]\,(F2\,\text{Cos}[\beta] + F1\,\text{Sin}[\beta])\right)\right) \Big/ \left(Ym\left(A1\,\text{Cos}[\alpha]\left(A2 + A3\,\text{Cos}[\beta]^3\right)\text{Sin}[\alpha]^2 + 2\,A1\,A3\,\text{Cos}[\alpha]^2\,\text{Cos}[\beta]^2\,\text{Sin}[\alpha]\,\text{Sin}[\beta] + A2\,A3\,\text{Cos}[\beta]\,\text{Sin}[\beta]^2 + A1\,A3\,\text{Cos}[\alpha]^3\,\text{Cos}[\beta]\,\text{Sin}[\beta]^2\right)\right),$$
$$\left(L\left(A2\,F2 + A1\,F2\,\text{Cos}[\alpha]^3 + A3\,F2\,\text{Cos}[\beta]^3 - A1\,F1\,\text{Cos}[\alpha]^2\,\text{Sin}[\alpha] + A3\,F1\,\text{Cos}[\beta]^2\,\text{Sin}[\beta]\right)\right) \Big/ \left(Ym\left(A1\,\text{Cos}[\alpha]\left(A2 + A3\,\text{Cos}[\beta]^3\right)\text{Sin}[\alpha]^2 + 2\,A1\,A3\,\text{Cos}[\alpha]^2\,\text{Cos}[\beta]^2\,\text{Sin}[\alpha]\,\text{Sin}[\beta] + A2\,A3\,\text{Cos}[\beta]\,\text{Sin}[\beta]^2 + A1\,A3\,\text{Cos}[\alpha]^3\,\text{Cos}[\beta]\,\text{Sin}[\beta]^2\right)\right)\right\}$$

```
α = 45 Degree
β = 45 Degree
F1 = 400
F2 = 400
A3 = A1
K
v = Simplify[v]
```

45°

45°

400

400

A1

$$\left\{\left\{\frac{\left(\frac{A1}{\sqrt{2}}+A2\right) Ym}{L}, 0\right\}, \left\{0, \frac{A1\, Ym}{\sqrt{2}\, L}\right\}\right\}$$

$$\left\{\frac{400\sqrt{2}\, L}{A1\, Ym+\sqrt{2}\, A2\, Ym}, \frac{400\left(\sqrt{2}\, A1+2\, A2\right) L}{A1\left(A1+\sqrt{2}\, A2\right) Ym}\right\}$$

```
s = -Inverse[F].GT.v;
s = Simplify[s]
```

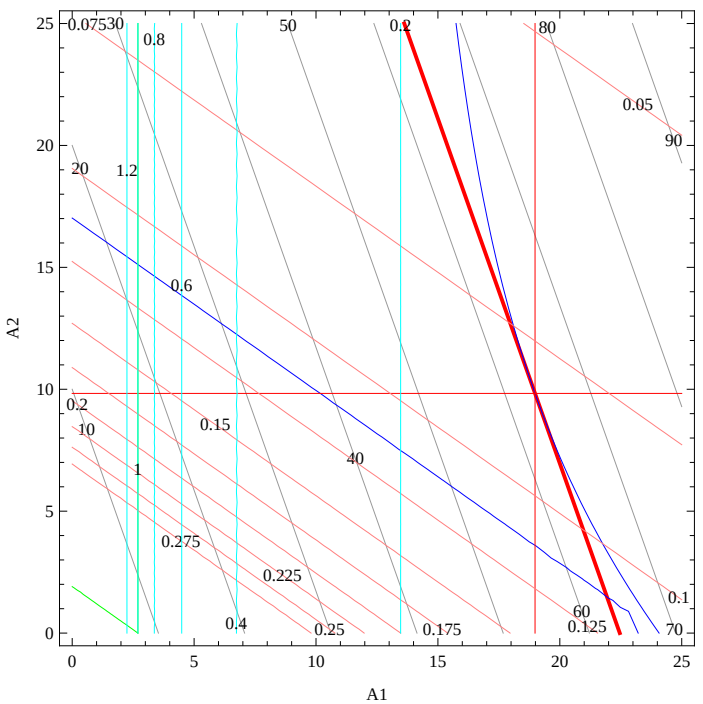
$$\left\{\frac{400\left(\sqrt{2}\, A1+A2\right)}{A1+\sqrt{2}\, A2}, \frac{400\sqrt{2}\, A2}{A1+\sqrt{2}\, A2}, -\frac{400\, A2}{A1+\sqrt{2}\, A2}\right\}$$

```
L = 100;
Ym = 21 000;
Sh = 23.5;

A1h = Abs[Simplify[s[[1]] / Sh]];
A2h = Abs[Simplify[s[[2]] / Sh]];
A3h = Abs[Simplify[s[[3]] / Sh]];

v
Clear[A1, A2]
NMinimize[{A1 / Ca + A2 + A3 / Cb, {A1 ≥ A1h, A2 ≥ A2h, A3 ≥ A3h, v[[1]] ≤ 1, v[[2]] ≤ 1}},
 {{A1, 0, 25}, {A2, 0, 25}}]
```

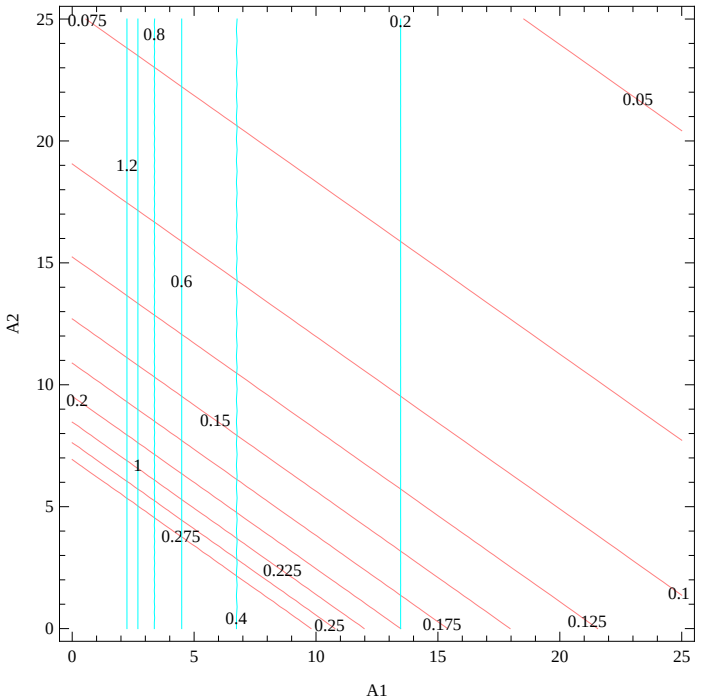
$$\left\{\frac{40\,000\sqrt{2}}{21\,000\, A1+21\,000\sqrt{2}\, A2}, \frac{40\left(\sqrt{2}\, A1+2\, A2\right)}{21\, A1\left(A1+\sqrt{2}\, A2\right)}\right\}$$

$\{63.5243, \{A1 \to 18.9839, A2 \to 9.82982\}\}$

```
p1 = ContourPlot[A1 / Ca + A2 + A3 / Cb, {A1, 0, 25}, {A2, 0, 25},
    ContourShading → None, FrameLabel → Automatic, ContourLabels → True];
p2 = ContourPlot[A1 / Ca + A2 + A3 / Cb == 63.5242692681836‘,
    {A1, 0, 25}, {A2, 0, 25}, ContourStyle → {Red, Thick}];
p3 = ContourPlot[{A1 == A1h, A2 == A2h}, {A1, 0, 25}, {A2, 0, 25}, ContourStyle → Blue];
p4 = ContourPlot[{A1 == 18.98385342434855‘, A2 == 9.82982331055032‘},
    {A1, 0, 25}, {A2, 0, 25}, ContourStyle → Red];
p5 = ContourPlot[{v[[1]] == 1, v[[2]] == 1}, {A1, 0, 25},
    {A2, 0, 25}, ContourStyle → Green];
p6 = ContourPlot[v[[1]], {A1, 0, 25}, {A2, 0, 25}, ContourShading → None,
    FrameLabel → Automatic, ContourLabels → True, ContourStyle → Pink];
p7 = ContourPlot[v[[2]], {A1, 0, 25}, {A2, 0, 25}, ContourShading → None,
    FrameLabel → Automatic, ContourLabels → True, ContourStyle → Cyan];
Show[p1, p2, p3, p4, p5, p6, p7]
```



```
Show[p6, p7]
```




```
A1 = 18.98385342434855‘
A2 = 9.82982331055032‘
```

```
18.9839
```

```
9.82982
```

```
v
```

```
{0.0819131, 0.141896}
```

```
Clear[A1, A2]
```

$$\mathbf{v = \left\{\frac{400\sqrt{2}\ L}{A1\ Ym + \sqrt{2}\ A2\ Ym},\ \frac{400\left(\sqrt{2}\ A1 + 2\,A2\right) L}{A1\left(A1 + \sqrt{2}\ A2\right) Ym}\right\}}$$

```
NMinimize[{A1 / Ca + A2 + A3 / Cb,
  {A1 ≥ A1h, A2 ≥ A2h, A3 ≥ A3h, v[[1]] ≤ 0.1, v[[2]] ≤ 0.1}}, {{A1, 0, 25}, {A2, 0, 25}}]
```

$$\left\{\frac{40\,000\sqrt{2}}{21\,000\,A1 + 21\,000\sqrt{2}\ A2},\ \frac{40\left(\sqrt{2}\ A1 + 2\,A2\right)}{21\,A1\left(A1 + \sqrt{2}\ A2\right)}\right\}$$

NMinimize::incst : NMinimize was unable to generate any initial points satisfying the inequality

$$\text{constraints}\left\{-0.1 + \frac{40\left(\sqrt{2}\ A1 + 2\,A2\right)}{21\,A1\left(A1 + \sqrt{2}\ A2\right)} \le 0,\ \text{≪3≫},\ -A1 + \text{Abs}\left[\frac{24.0717\ \text{≪2≫}\ \text{≪1≫}\ \text{≪1≫}}{A1 + \text{Power[≪2≫]}\,A2}\right] \le 0\right\}.$$

The initial region specified may not contain any feasible points. Changing the initial region or specifying explicit initial points may provide a better solution. ≫

$$\left\{76.1905,\ \left\{A1 \to 26.9374,\ A2 \to 6.18583 \times 10^{-7}\right\}\right\}$$