```
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 = 0
A3 = A1
K
v = Simplify[v]
```

45°

45°

400

0

A1

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

$$\left\{\frac{400\sqrt{2}\, L}{A1\, Ym + \sqrt{2}\, A2\, Ym}, 0\right\}$$

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

$$\left\{\frac{200\sqrt{2}\, A1}{A1+\sqrt{2}\, A2}, \frac{400\sqrt{2}\, A2}{A1+\sqrt{2}\, A2}, \frac{200\sqrt{2}\, A1}{A1+\sqrt{2}\, A2}\right\}$$

```
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

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

$$\left\{\frac{40\,000\sqrt{2}}{21\,000\, A1 + 21\,000\sqrt{2}\, A2}, 0\right\}$$

$$\left\{17.0213, \left\{A1 \to 1.6868 \times 10^{-7}, A2 \to 17.0213\right\}\right\}$$

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

$$\left\{17.0213, \left\{A1 \to 1.6868 \times 10^{-7}, A2 \to 17.0213\right\}\right\}$$

```
p1 = ContourPlot[A1 / Ca + A2 + A3 / Cb, {A1, 0, 5}, {A2, 15, 20},
    ContourShading → None, FrameLabel → Automatic, ContourLabels → True];
p2 = ContourPlot[A1 / Ca + A2 + A3 / Cb == 17.021276950478818‘,
    {A1, 0, 5}, {A2, 15, 20}, ContourStyle → {Red, Thick}];
p3 = ContourPlot[{A1 == A1h, A2 == A2h}, {A1, 0, 5}, {A2, 15, 20}, ContourStyle → Blue];
p4 = ContourPlot[{A1 == 1.6867966180165743‘*^-7, A2 == 17.021276473380688‘},
    {A1, 0, 5}, {A2, 15, 20}, ContourStyle → Red];
p5 = ContourPlot[{v[[1]] == 1}, {A1, 0, 5}, {A2, 15, 20}, ContourStyle → Blue];
Show[p1, p2, p3, p4, p5]
```