```
s = ρ * ϕ;
θ = ArcSin[(ρ / R) Sin[ϕ]];
f1 = ρ / Tan[ϕ - θ + ξ];
f2 = ρ / Tan[ϕ - θ - ξ];
d = 2 R * Sin[ϕ - θ];
R = ρ (1 + F^2);
k = κ * ρ / R;
kx = Sqrt[1 + k] / ρ;
ky = Sqrt[k] / ρ;
```

$$M_z := \left(\begin{pmatrix} \mathrm{Cosh}[k_y\, s] & \mathrm{Sinh}[k_y\, s] / k_y \\ k_y\, \mathrm{Sinh}[k_y\, s] & \mathrm{Cosh}[k_y\, s] \end{pmatrix} . \begin{pmatrix} 1 & 0 \\ -\frac{1}{f_2} & 1 \end{pmatrix} . \begin{pmatrix} 1 & d \\ 0 & 1 \end{pmatrix} . \begin{pmatrix} 1 & 0 \\ -\frac{1}{f_1} & 1 \end{pmatrix} . \begin{pmatrix} \mathrm{Cosh}[k_y\, s] & \mathrm{Sinh}[k_y\, s] / k_y \\ k_y\, \mathrm{Sinh}[k_y\, s] & \mathrm{Cosh}[k_y\, s] \end{pmatrix}\right)$$

```
νz^2 = FullSimplify[
   (ArcCos[Series[
      (Mz[[1, 1]] + Mz[[2, 2]]) / 2,
      {ϕ, 0, 3}]]) / (2 ϕ)] ^2
```

$$\left(-\kappa + F^2 \left(1 + 2\, \mathrm{Tan}[\xi]^2\right)\right) + O[\phi]^2$$

$$M_r := \left(\begin{pmatrix} \mathrm{Cos}[k_x\, s] & \mathrm{Sin}[k_x\, s] / k_x \\ -k_x\, \mathrm{Sin}[k_x\, s] & \mathrm{Cos}[k_x\, s] \end{pmatrix} . \begin{pmatrix} 1 & 0 \\ \frac{1}{f_2} & 1 \end{pmatrix} . \begin{pmatrix} 1 & d \\ 0 & 1 \end{pmatrix} . \begin{pmatrix} 1 & 0 \\ \frac{1}{f_1} & 1 \end{pmatrix} . \begin{pmatrix} \mathrm{Cos}[k_x\, s] & \mathrm{Sin}[k_x\, s] / k_x \\ -k_x\, \mathrm{Sin}[k_x\, s] & \mathrm{Cos}[k_x\, s] \end{pmatrix}\right)$$

```
νr^2 = FullSimplify[
   ArcCos[Series[
     (Mr[[1, 1]] + Mr[[2, 2]]) / 2,
     {ϕ, 0, 3}]] / (2 ϕ)] ^2
```

$$(1 + \kappa) + O[\phi]^2$$