

$$\begin{aligned}
 F_{ql} &= \int_0^{q_0 - kq \cdot y} \int_0^{l_B} dy dz = \int_0^{l_B} (q_0 - kq \cdot y) dy \\
 &= \left[q_0 \cdot y - kq \frac{y^2}{2} \right]_0^{l_B} = q_0 \cdot l_B - kq \frac{l_B^2}{2} \quad (4.2.2)
 \end{aligned}$$

$$\begin{aligned}
 F_{qr} &= \int_0^{q_0 - kq y_0} \int_{-l_B}^0 dy dz = \int_{-l_B}^0 (q_0 - kq \cdot y) dy \\
 &= \left[q_0 y - kq \frac{y^2}{2} \right]_{-l_B}^0 = q_0 + kq \frac{l_B^2}{2} \quad (4.2.3)
 \end{aligned}$$

$$\begin{aligned}
 y_{Sl} &= \frac{1}{F_{ql}} \int_0^{q_0 - kq \cdot y} \int_0^{l_B} y \cdot dy dz = \frac{1}{F_{ql}} \int_0^{l_B} (q_0 - kq \cdot y) y dy \\
 &= \frac{1}{F_{ql}} \left[q_0 \frac{y^2}{2} - kq \frac{y^3}{3} \right]_0^{l_B} = \frac{1}{F_{ql}} \left(q_0 \frac{l_B^2}{2} - kq \frac{l_B^3}{3} \right) \quad (4.2.4)
 \end{aligned}$$

$$\begin{aligned}
 y_{Sr} &= \frac{1}{F_{qr}} \int_0^{q_0 - kq y_0} \int_{-l_B}^0 y dy dz = \frac{1}{F_{qr}} \int_{-l_B}^0 (q_0 - kq \cdot y) y dy \\
 &= \frac{1}{F_{qr}} \left[q_0 \frac{y^2}{2} - kq \frac{y^3}{3} \right]_{-l_B}^0 = \frac{1}{F_{qr}} \left(-q_0 \frac{l_B^2}{2} - kq \frac{l_B^3}{3} \right) \quad (4.2.5)
 \end{aligned}$$

$$\Sigma F_y = 0 = F_{Ayges} - F_{Ry} \quad (4.2.7)$$

$$F_{Ayges} = 2 q_0 l_B \mu_B \quad (4.2.8)$$

$$\begin{aligned} \Sigma F_z = 0 &= F_S - F_{RAges} - (F_{ql} + F_{qr}) \\ &= F_S - F_{RAges} \mu_A - 2 q_0 l_B \\ &= F_S - 2 q_0 l_B (\mu_A \mu_B + 1) \end{aligned} \quad (4.2.9)$$

$$\begin{aligned} \Sigma M_x = 0 &= F_S a - F_{Ayges} h_A - F_{RAges} a_1 - F_{ql} l_{ySL} + F_{qr} l_{ySL} \\ &= \frac{3}{2} \frac{a}{l_B^3} F_S - q_0 \frac{3}{l_B^2} \mu_A (h_A + \mu_A a_1) + k_0 \end{aligned} \quad (4.2.11)$$

$$\begin{aligned} k_0 &= q_0 \frac{3}{l_B^2} \mu_B (h_A + \mu_A a_1) - \frac{3}{2} \frac{a}{l_B^3} F_S \\ &= F_S \frac{3}{2} \frac{\mu_B (h_A + \mu_A a_1)}{l_B^3 (\mu_A \mu_B + 1)} - \frac{3}{2} \frac{a}{l_B^3} F_S \end{aligned} \quad (4.2.12)$$

$$\sum M_{A1} = 0 = F_{A2y} (b_1 - b_2)$$

$$\begin{aligned} & - \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) (b_1 - |x_{ij}|) \\ & - \sum_i \sum_j [F_{Rlijx} (a_1 - |y_{ij}|) - F_{Rrijx} (a_1 + |y_{ij}|)] \\ & = F_{A2y} (b_1 - b_2) \end{aligned}$$

$$\begin{aligned} & - b_1 \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ & + \sum_i \sum_j |x_{ij}| (F_{Rlijy} + F_{Rrijy}) \\ & - a_1 \sum_i \sum_j (F_{Rlijx} - F_{Rrijx}) \\ & + \sum_i \sum_j |y_{ij}| (F_{Rlijx} - F_{Rrijx}) \end{aligned}$$

$$= F_{A2y} (b_1 - b_2)$$

$$\begin{aligned} & - 2 b_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |x_{ij}| \\ & + C_9 b_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\ & + C_{10} b_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\ & + C_{11} b_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \\ & + 2 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |x_{ij}|^2 \\ & - C_9 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 \\ & - C_{10} \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^3 \end{aligned}$$

$$\begin{aligned}
& -C_{11} \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 |y_{ij}| \\
& + C_9 a_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}| \\
& + C_{10} a_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \\
& + C_{11} a_1 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^2 \\
& + 2 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |y_{ij}|^2 \\
& - C_9 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^2 \\
& - C_{10} \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}|^2 \\
& - C_{11} \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^3 \quad (4.3.27)
\end{aligned}$$

$$S_{15} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |x_{ij}| \quad (4.3.28)$$

$$S_{16} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |x_{ij}|^2 \quad (4.3.29)$$

$$S_{17} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |y_{ij}| \quad (4.3.30)$$

$$S_{18} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |y_{ij}|^2 \quad (4.3.31)$$

$$S_{19} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \quad (4.3.32)$$

$$S_{20} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 \quad (4.3.33)$$

$$S_{21} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^3 \quad (4.3.34)$$

$$S_{22} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \quad (4.3.35)$$

$$S_{23} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 |y_{ij}| \quad (4.3.36)$$

$$S_{24} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}|^2 \quad (4.3.37)$$

$$S_{25} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}| \quad (4.3.38)$$

$$S_{26} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^2 \quad (4.3.39)$$

$$S_{27} = \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{Lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^3 \quad (4.3.40)$$

Gl. 4.3.28 bis 4.3.40 in Gl. 4.3.27:

$$\begin{aligned} 0 = & F_{A2y} (b_1 - b_2) \\ & + C_9 (b_1 S_{19} - S_{20} + a_1 S_{25} - S_{26}) \\ & + C_{10} (b_1 S_{20} - S_{21} + a_1 S_{22} - S_{24}) \\ & + C_{11} (b_1 S_{22} - S_{23} + a_1 S_{26} - S_{27}) \\ & + 2(S_{16} + S_{18} - b_1 S_{15}) \end{aligned} \quad (4.3.41)$$

$$\Sigma M_{A2} = 0 = -F_{A1y} (b_1 - b_2)$$

$$- \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) (b_2 - |x_{ij}|)$$

$$- \sum_i \sum_j [F_{Rlijx} (a_1 - |y|) - F_{Rrijx} (a_1 + |y_{ij}|)]$$

$$= -F_{A1y} (b_1 - b_2)$$

$$+ C_9 (b_2 S_{19} - S_{20} + a_1 S_{25} - S_{26})$$

$$+ C_{10} (b_2 S_{20} - S_{21} + a_1 S_{22} - S_{24})$$

$$\begin{aligned}
& + C_{11}(b_2 S_{20} - S_{23} + a_1 S_{26} - S_{27}) \\
& + 2(S_{16} + S_{18} - b_2 S_{15})
\end{aligned} \tag{4.3.43}$$

$$\begin{aligned}
\Sigma F_z = 0 &= F_S - \mu_A (F_{A1y} + F_{A2y}) - \sum_i \sum_j (F_{Mij} + F_{Nrij}) \\
&= F_S - \mu_A (F_{A1y} + F_{A2y}) \\
&\quad - 2 \sum_i E_i A_i \sum_j 1 \\
&\quad + C_9 \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) \\
&\quad + C_{10} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\
&\quad + C_{11} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|
\end{aligned} \tag{4.3.45}$$

$$S_{28} = \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) \tag{4.3.46}$$

$$S_{29} = \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \tag{4.3.47}$$

$$S_{30} = \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}| \tag{4.3.48}$$

$$S_{31} = \sum_i E_i A_i \sum_j 1 \tag{4.3.49}$$

Gl. 4.3.42, 4.3.44, 4.3.46 bis 4.3.49 in Gl. 4.3.45:

$$\begin{aligned}
0 &= F_S \\
&\quad + C_9 \mu_A S_{19} + C_{10} \mu_A S_{20} + C_{11} \mu_A S_{22} - 2 \mu_A S_{15} \\
&\quad + C_9 S_{28} + C_{10} S_{29} + C_{11} S_{30} - 2 S_{31}
\end{aligned} \tag{4.3.50}$$

$$\begin{aligned}
\Sigma M_x = 0 &= F_S a - F_{A1y} h_{A1} - F_{A2y} h_{A2} - \alpha_1 \mu_A (F_{A1y} + F_{A2y}) \\
&\quad - \sum_i \sum_j (F_{Nlij} - F_{Nr_{ij}}) |y_{ij}| \\
&= F_S a - F_{A1y} h_{A1} - F_{A2y} h_{A2} - \alpha_1 \mu_A (F_{A1y} + F_{A2y}) \\
&\quad + C_9 \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |y_{ij}| \\
&\quad + C_{10} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |x_{ij}| |y_{ij}| \\
&\quad + C_{11} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |y_{ij}|^2 \quad (4.3.52)
\end{aligned}$$

$$S_{33} = \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |x_{ij}| |y_{ij}| \quad (4.3.53)$$

$$S_{34} = \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |y_{ij}|^2 \quad (4.3.54)$$

$$0 = F_S a$$

$$+ C_9 \frac{S_{19}(h_{A1}b_2 - h_{A2}b_1) - (h_{A1} - h_{A2})(S_{20} - \alpha_1 S_{25} + S_{26})}{b_2 b_1}$$

$$+ C_{10} \frac{S_{20}(h_{A1}b_2 - h_{A2}b_1) - (h_{A1} - h_{A2})(S_{21} - \alpha_1 S_{22} + S_{24})}{b_2 - b_1}$$

$$+ C_{11} \frac{S_{22}(h_{A1}b_2 - h_{A2}b_1) - (h_{A1} - h_{A2})(S_{23} - \alpha_1 S_{26} + S_{27})}{b_2 - b_1}$$

$$- 2 \frac{S_{15}(h_{A1}b_2 - h_{A2}b_1) - (h_{A1} - h_{A2})(S_{16} + S_{18})}{b_2 - b_1}$$

$$+ C_9 \alpha_1 \mu_A S_{19} + C_{10} \alpha_1 \mu_A S_{20} + C_{11} \alpha_1 \mu_A S_{22} - 2 \alpha_1 \mu_A S_{15}$$

$$+ C_9 S_{30} + C_{10} S_{33} + C_{11} S_{34} \quad (4.3.55)$$

$$\begin{aligned} \sum M_y = 0 &= F_S b - \mu_A (F_{A1y} b_1 + F_{A2y} b_2) - \sum_i \sum_j (F_{Mij} + F_{Nrij}) |x_{ij}| \\ &= F_S b - \mu_A (F_{A1y} b_1 + F_{A2y} b_2) \\ &\quad - 2 \sum_i E_i A_i \sum_j |x_{ij}| \\ &\quad + C_9 \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\ &\quad + C_{10} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 \\ &\quad + C_{11} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \end{aligned} \quad (4.3.57)$$

$$S_{35} = \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 \quad (4.3.58)$$

$$S_{36} = \sum_i E_i A_i \sum_j |x_{ij}| \quad (4.3.59)$$

$$0 = F_S b$$

$$\begin{aligned} &+ C_9 \mu_A (S_{20} - \alpha_1 S_{25} + S_{26}) + C_{10} \mu_A (S_{21} - \alpha_1 S_{22} + S_{24}) \\ &+ C_{11} \mu_A (S_{23} - \alpha_1 S_{26} + S_{27}) - 2 \mu_A (S_{16} + S_{18}) \\ &+ C_9 S_{29} + C_{10} S_{35} + C_{11} S_{33} - 2 S_{36} \end{aligned} \quad (4.3.60)$$

$$C_{h1} = \mu_A S_{19} + S_{28} \quad (4.3.62)$$

$$C_{h2} = \mu_A S_{20} + S_{29} \quad (4.3.63)$$

$$C_{h3} = \mu_A S_{22} + S_{30} \quad (4.3.64)$$

$$C_{h4} = 2(\mu_A S_{15} + S_{31}) - F_S \quad (4.3.65)$$

$$C_{h5} = \frac{S_{19}(h_{A1}b_1 - h_{A2}b_2) - (h_{A1} - h_{A2})(S_{20} - a_1 S_{25} + S_{26})}{b_2 - b_1} + a_1 \mu_A S_{19} + S_{30} \quad (4.3.66)$$

$$C_{h6} = \frac{S_{20}(h_{A1}b_1 - h_{A2}b_2) - (h_{A1} - h_{A2})(S_{21} - a_1 S_{22} + S_{24})}{b_2 - b_1} + a_1 \mu_A S_{20} + S_{33} \quad (4.3.67)$$

$$C_{h7} = \frac{S_{22}(h_{A1}b_1 - h_{A2}b_2) - (h_{A1} - h_{A2})(S_{23} - a_1 S_{26} + S_{27})}{b_2 - b_1} + a_1 \mu_A S_{22} + S_{34} \quad (4.3.68)$$

$$C_{h8} = 2 \left[\frac{S_{15}(h_{A1}b_1 - h_{A2}b_2) - (h_{A1} - h_{A2})(S_{16} + S_{18})}{b_2 - b_1} \right] + 2a_1 \mu_A S_{15} - F_S a \quad (4.3.69)$$

$$C_{h9} = \mu_A (S_{20} - a_1 S_{25} + S_{26}) + S_{29} \quad (4.3.70)$$

$$C_{h10} = \mu_A (S_{21} - a_1 S_{22} + S_{24}) + S_{35} \quad (4.3.71)$$

$$C_{h11} = \mu_A (S_{23} - a_1 S_{26} + S_{27}) + S_{33} \quad (4.3.72)$$

$$C_{h12} = 2 \left[\mu_A (S_{16} + S_{18}) + S_{36} \right] - F_S b \quad (4.3.73)$$

$$\begin{aligned}
\sum F_z = 0 &= F_S - \sum_i \sum_j (F_{Mij} + F_{Nrij}) \\
&= F_S - 2C_{12} \sum_i A_i \sum_j 1 - 2C_{13} \sum_i A_i \sum_j |x_{ij}| \\
&= \frac{F_S}{2} - C_{12} S_4 - C_{13} S_2
\end{aligned} \tag{4.3.97}$$

$$\begin{aligned}
\sum M_x = 0 &= F_S a - \sum_i \sum_j (F_{Mij} - F_{Nrij}) |y_{ij}| \\
&= F_S a - 2C_{14} |y_{ij}| \\
&= F_S \frac{a}{2} - C_{14} S_1
\end{aligned} \tag{4.3.98}$$

$$\begin{aligned}
\sum M_y = 0 &= F_S b - \sum_i \sum_j (F_{Mij} + F_{Nrij}) |x_{ij}| \\
&= F_S b - 2C_{12} \sum_i \sum_j |x_{ij}| - 2C_{13} \sum_i \sum_j |x_{ij}|^2 \\
&= F_S b \frac{b}{2} - C_{12} S_2 - C_{13} S_3
\end{aligned} \tag{4.3.99}$$

$$C_{14} = \frac{F_S \cdot a}{2 \cdot S_1} \tag{4.3.100}$$

$$C_{13} = \frac{F_S \cdot b S_4 - S_2}{2 \cdot S_3 S_4 - S_2^2} \tag{4.3.101}$$

$$C_{12} = \frac{F_S \cdot S_3 - b S_2}{2 \cdot S_3 S_4 - S_2} \tag{4.3.102}$$

$$\begin{aligned}
\sum F_y = 0 &= F_{A1y} - \sum_i \sum_j (F_{Rlijy} + F_{Rrij}) \\
&= F_{A1y} - 2\mu_B C_{12} \sum_i \sum_j |x_{ij}| - 2\mu_B C_{13} \sum_i \sum_j |x_{ij}|^2
\end{aligned} \tag{4.3.103}$$

$$S_{37} = \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}|^2 \quad (4.3.104)$$

$$S_{38} = \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}| \quad (4.3.105)$$

$$\sum F_y = 0 = F_{A1y} - 2\mu_B C_{12} S_{38} - 2\mu_B C_{13} S_{37} \quad (4.3.106)$$

$$\sum M_{A1} = 0 = F_{A3x} (a_2 + a_3)$$

$$+ \sum_i \sum_j [F_{RLijx} (a_2 - |y_{ij}|) - F_{Rrijx} (a_2 + |y_{ij}|)]$$

$$- \sum_i \sum_j (F_{RLijy} + F_{Rrijy}) (|x_{ij}| - b_1)$$

$$= F_{A3x} (a_2 + a_3)$$

$$+ a_2 \sum_i \sum_j (F_{RLijx} - F_{Rrijx})$$

$$- \sum_i \sum_j (F_{RLijx} + F_{Rrijx}) |y_{ij}|$$

$$+ b_1 \sum_i \sum_j (F_{RLijy} + F_{Rrijy})$$

$$- \sum_i \sum_j (F_{RLijy} + F_{Rrijy}) |x_{ij}|$$

$$= F_{A3x} (a_2 + a_3)$$

$$+ 2a_2 \mu_B C_{14} \sum_i \frac{A_i}{r_{Si}} \sum_j |y_{ij}|^2$$

$$- 2\mu_B C_{12} \sum_i \frac{A_i}{r_{Si}} \sum_j |y_{ij}|^2$$

$$- 2\mu_B C_{13} \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}| |y_{ij}|^2$$

$$\begin{aligned}
& + 2b_1 \mu_B C_{12} \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}| \\
& + 2b_1 \mu_B C_{13} \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}|^2 \\
& - 2 \mu_B C_{12} \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}|^2 \\
& - 2 \mu_B C_{13} \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}|^3
\end{aligned} \tag{4.3.107}$$

$$S_{39} = \sum_i \frac{A_i}{r_{Si}} \sum_j |y_{ij}|^2 \tag{4.3.108}$$

$$S_{40} = \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}| |y_{ij}|^2 \tag{4.3.109}$$

$$S_{41} = \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}|^3 \tag{4.3.110}$$

$$\begin{aligned}
\sum M_{A1} = 0 = F_{A3x} (a_2 + a_3) \\
- 2 \mu_B C_{12} (S_{39} - b_1 S_{38} + S_{37}) \\
- 2 \mu_B C_{13} (S_{40} - b_1 S_{37} + S_{41}) \\
+ 2 \mu_B C_{14} a_1 S_{39}
\end{aligned} \tag{4.3.111}$$

Gl. 4.3.101, 4.3.96 u. 4.3.97:

$$\frac{F_{A1y}}{F_S \mu_A} = \frac{S_{38}(S_3 - bS_2) + S_{37}(bS_4 - S_2)}{S_3 S_4 - S_2^2} \tag{4.3.112}$$

Gl. 4.3.106, 4.3.95 bis 4.3.97:

$$\frac{F_{A3x}}{F_S \mu_A} = \frac{1}{a_2 + a_3} \sqrt{\frac{(S_3 - bS_2)(S_{39} - b_1 S_{38} + S_{37})}{S_3 S_4 - S_2^2}}$$

$$+ \frac{(bS_4 - S_2)(S_{40} - b_1 S_{37} + S_{41})}{S_3 S_4 - S_2^2} - \frac{a \cdot a_1 S_{39}}{S_1} \quad (4.3.113)$$

$$\begin{aligned} \sum F_x = 0 &= -F_{A2x} + F_{A3x} + \sum_i \sum_j (F_{Rlijx} - F_{Rrijx}) \\ &= -F_{A2x} + F_{A3x} + 2\mu_B C_{14} \sum_i \frac{A_i}{r_{Si}} \sum_j |y_{ij}|^2 \\ &= -F_{A2x} + F_{A3x} + 2\mu_B C_{14} S_{39} \end{aligned} \quad (4.3.114)$$

Gl. 4.3.95, 4.3.108 u. 4.3.109:

$$\frac{F_{A2x}}{F_S \mu_B} = \frac{F_{A3x}}{F_S \mu_B} + a \frac{S_{39}}{S_1} \quad (4.3.115)$$

$$\begin{aligned} \sum F_y = 0 &= -F_{A1y} + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ &= -F_{A1y} \\ &\quad + 2 \sum_i \frac{E_i A_i \mu_i}{r_{Si}} \sum_j |x_{ij}| \\ &\quad - C_9 \sum_i \frac{E_i A_i \mu_i}{r_{Si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\ &\quad - C_{10} \sum_i \frac{E_i A_i \mu_i}{r_{Si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\ &\quad - C_{11} \sum_i \frac{E_i A_i \mu_i}{r_{Si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \end{aligned} \quad (4.3.118)$$

$$\begin{aligned} \sum M_{A2} = 0 &= F_{A3x} (a_2 + a_3) + F_{A1y} (b_1 - b_2) \\ &\quad - \sum_i \sum_j (F_{Rlij} + F_{Rrij}) (|x_{ij}| - b_2) \end{aligned}$$

$$\begin{aligned}
& -C_{10} a_2 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \\
& -C_{11} a_2 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^2 \\
& -2 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j |y_{ij}|^2 \\
& +C_9 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^2 \\
& +C_{10} \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}|^2 \\
& +C_{11} \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^3 \\
& = F_{A3x} (a_2 + a_3) \\
& -C_9 b_1 S_{19} - C_{10} b_1 S_{20} - C_{11} b_1 S_{22} + 2 b_1 S_{15} \\
& +C_9 b_2 S_{19} + C_{10} b_2 S_{20} + C_{11} b_2 S_{22} - 2 b_2 S_{15} \\
& -C_9 b_2 S_{19} - C_{10} b_2 S_{20} - C_{11} b_2 S_{22} + 2 b_2 S_{15} \\
& +C_9 S_{20} + C_{10} S_{21} + C_{11} S_{23} - 2 S_{16} \\
& -C_9 a_2 S_{25} - C_{10} a_2 S_{22} - C_{11} a_2 S_{26} \\
& +C_9 S_{26} + C_{10} S_{24} + C_{11} S_{27} - 2 S_{18} \quad (4.3.120)
\end{aligned}$$

$$\Sigma F_x = 0 = -F_{A2x} + F_{A3x} + \sum_i \sum_j (F_{Rlijx} - F_{Rrijy})$$

$$= -F_{A2x} + F_{A3x}$$

$$+C_9 \sum_i \frac{E_i A_i \mu_i}{r_{s_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|$$

$$+ \sum_i \sum_j [F_{Rlijx} (a_2 - |y_{ij}|) - F_{Rrijx} (a_2 + |y_{ij}|)]$$

$$= F_{A3x} (a_2 + a_3) + F_{A2y} (b_1 - b_2)$$

$$+ b_2 \sum_i \sum_j (F_{Rlij} + F_{Rrij})$$

$$- \sum_i \sum_j (F_{Rlij} + F_{Rrij}) |x_{ij}|$$

$$+ a_2 \sum_i \sum_j (F_{Rlijx} - F_{Rrijx})$$

$$- \sum_i \sum_j (F_{Rlijx} + F_{Rrijx}) |y_{ij}|$$

$$= F_{A3x} (a_2 + a_3) + F_{A1y} (b_1 - b_2)$$

$$+ 2b_2 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j |x_{ij}|$$

$$- C_9 b_2 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|$$

$$- C_{10} b_2 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2$$

$$- C_{11} b_2 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}|$$

$$- 2 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j |x_{ij}|^2$$

$$+ C_9 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2$$

$$+ C_{10} \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^3$$

$$+ C_{11} \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 |y_{ij}|$$

$$- C_9 a_2 \sum_i \frac{E_i A_i \mu_i}{r_{si}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|$$

$$\begin{aligned}
& + C_{10} \sum_i \frac{E_i A_i \mu_i}{r_{S_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \\
& + C_{11} \sum_i \frac{E_i A_i \mu_i}{r_{S_i}} \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}|^2 \\
& = -F_{A2_x} + F_{A3_x} + C_9 S_{25} + C_{10} S_{22} + C_{11} S_{26} \quad (4.3.122)
\end{aligned}$$

$$\begin{aligned}
\Sigma F_z = 0 & = F_S - \mu_A (F_{A1_y} + F_{A2_x} v_{z2} + F_{A3_x} v_{z3}) \\
& \quad - \sum_i \sum_j (F_{Nlij} + F_{Nr_{ij}}) \\
& = F_S - \mu_A (F_{A1_y} + F_{A2_x} v_{z2} + F_{A3_x} v_{z3}) \\
& \quad - \sum_i \sum_j (F_{Nlij} + F_{Nr_{ij}}) \\
& = F_S - \mu_A (F_{A1_y} + F_{A2_x} v_{z2} + F_{A3_x} v_{z3}) \\
& \quad - 2 \sum_i E_i A_i \sum_j 1 \\
& \quad + C_9 \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) \\
& \quad + C_{10} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\
& \quad + C_{11} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |y_{ij}| \\
& = F_S - \mu_A (F_{A1_y} + F_{A2_x} v_{z2} + F_{A3_x} v_{z3}) \\
& \quad + C_9 S_{28} + C_{10} S_{29} + C_{11} S_{30} - 2 S_{31} \quad (4.3.124)
\end{aligned}$$

$$\Sigma M_x = 0 = F_S a - F_{A1y} h_{A1} - \mu_A (F_{A1y} a_1 + F_{A2x} a_2 v_{z2}$$

$$- F_{A3x} a_3 v_{z3}) - \sum_i \sum_j (F_{Nlij} - F_{Nr_{ij}}) |y_{ij}|$$

$$= F_S a - F_{A1y} h_{A1}$$

$$- \mu_A (F_{A1y} a_1 + F_{A2x} a_2 v_{z2} - F_{A3x} a_3 v_{z3})$$

$$- C_9 \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |y_{ij}|$$

$$- C_{10} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |x_{ij}| |y_{ij}|$$

$$- C_{11} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{r_{ij}}} \right) |y_{ij}|$$

$$= F_S a - F_{A1y} h_{A1}$$

$$- \mu_A (F_{A1y} a_1 + F_{A2x} a_2 v_{z2} - F_{A3x} a_3 v_{z3})$$

$$+ C_9 S_{30} + C_{10} S_{33} + C_{11} S_{34}$$

(4.3.126)

$$\Sigma M_y = 0 = F_S b - F_{A1y} \mu_A b_1$$

$$- F_{A2x} (\mu_A b_2 v_{z2} - h_{A2}) - F_{A3x} (\mu_A b_3 v_{z3} + h_{A3})$$

$$- \sum_i \sum_j (F_{Nlij} + F_{Nr_{ij}}) |x_{ij}|$$

$$= F_S b - F_{A1y} \mu_A b_1$$

$$- F_{A2x} (\mu_A b_2 v_{z2} - h_{A2}) - F_{A3x} (\mu_A b_3 v_{z3} + h_{A3})$$

$$\begin{aligned}
& + C_9 \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| \\
& + C_{10} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} + \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}|^2 \\
& + C_{11} \sum_i E_i A_i \sum_j \left(\frac{1}{h_0 - \Delta h_{lij}} - \frac{1}{h_0 - \Delta h_{rij}} \right) |x_{ij}| |y_{ij}| \\
& - 2 \sum_i E_i A_i \sum_j |x_{ij}| \\
& = F_S b - F_{A1y} \mu_A b_1 \\
& \quad - F_{A2x} (\mu_A b_2 v_{z2} - h_{A2}) \\
& \quad - F_{A3x} (\mu_A b_3 v_{z3} + h_{A3}) \\
& \quad + C_9 S_{29} + C_{10} S_{35} + C_{11} S_{33} - 2 S_{36} \tag{4.3.128}
\end{aligned}$$

$$\begin{aligned}
C_{h1} & = S_{28} + \mu_A S_{19} \\
& + \mu_A \frac{(v_{z2} + v_{z3})(S_{20} + S_{26} - b_1 S_{19}) + S_{25}(v_{z2} a_3 - v_{z3} a_2)}{a_2 + a_3} \tag{4.3.130}
\end{aligned}$$

$$\begin{aligned}
C_{h2} & = S_{29} + \mu_A S_{20} \\
& + \mu_A \frac{(v_{z2} + v_{z3})(S_{21} + S_{24} - b_1 S_{20}) + S_{22}(v_{z2} a_3 - v_{z3} a_2)}{a_2 + a_3} \tag{4.3.131}
\end{aligned}$$

$$\begin{aligned}
C_{h3} & = S_{30} + \mu_A S_{22} \\
& + \mu_A \frac{(v_{z2} + v_{z3})(S_{23} + S_{27} - b_1 S_{22}) + S_{26}(v_{z2} a_3 - v_{z3} a_2)}{a_2 + a_3} \tag{4.3.132}
\end{aligned}$$

$$C_{h4} = 2 \left[S_{31} + \mu_A S_{15} + \mu_A \frac{(v_{z2} + v_{z3})(S_{16} + S_{18} - b_1 S_{15})}{a_2 + a_3} \right] - F_S \tag{4.3.133}$$

$$C_{h5} = S_{30} + S_{19}(h_{A1} + \mu_A a_1) + \mu_A \frac{(a_2 v_{z2} - a_3 v_{z3})(S_{20} + S_{26} - b_1 S_{19}) + S_{25} a_2 a_3 (v_{z2} + v_{z3})}{a_2 + a_3} \quad (4.3.134)$$

$$C_{h6} = S_{33} + S_{20}(h_{A1} + \mu_A a_1) + \mu_A \frac{(a_2 v_{z2} - a_3 v_{z3})(S_{21} + S_{24} - b_1 S_{20}) + S_{22} a_2 a_3 (v_{z2} + v_{z3})}{a_2 + a_3} \quad (4.3.135)$$

$$C_{h7} = S_{37} + S_{22}(h_{A1} + \mu_A a_1) + \mu_A \frac{(a_2 v_{z2} - a_3 v_{z3})(S_{23} + S_{27} - b_1 S_{22}) + S_{26} a_2 a_3 (v_{z2} + v_{z3})}{a_2 + a_3} \quad (4.3.136)$$

$$C_{h8} = 2S_{15}(h_{A1} + \mu_A a_1) + \mu_A \frac{(a_2 v_{z2} - a_3 v_{z3})(S_{16} + S_{18} - b_1 S_{15})}{a_2 + a_3} - F_S a \quad (4.3.137)$$

$$C_{h9} = S_{29} + S_{19} \mu_A b_1 - \frac{(\mu_A b_2 v_{z2} - h_{A2})(S_{20} + S_{26} - b_1 S_{19} + a_3 S_{25})}{a_2 + a_3} + \frac{(\mu_A b_3 v_{z3} + h_{A3})(S_{20} + S_{26} - b_1 S_{19} - a_2 S_{25})}{a_2 + a_3} \quad (4.3.138)$$

$$C_{h10} = S_{35} + S_{20} \mu_A b_1 + \frac{(\mu_A b_2 v_{z2} - h_{A2})(S_{21} + S_{24} - b_1 S_{20} + a_3 S_{22})}{a_2 + a_3} + \frac{(\mu_A b_3 v_{z3} + h_{A3})(S_{21} + S_{24} - b_1 S_{20} - a_2 S_{22})}{a_2 + a_3} \quad (4.3.139)$$

$$\begin{aligned}
C_{h11} &= S_{33} + S_{22} \mu_A b_1 \\
&+ \frac{(\mu_A b_2 v z_2 - h_{A2})(S_{23} + S_{37} - b_1 S_{22} + a_3 S_{26})}{a_2 + a_3} \\
&+ \frac{(\mu_A b_3 v z_3 + h_{A3})(S_{23} + S_{37} - b_1 S_{22} - a_2 S_{26})}{a_2 + a_3}
\end{aligned} \tag{4.3.140}$$

$$\begin{aligned}
C_{h12} &= 2(S_{36} + S_{15} \mu_A b_1) - F_S b \\
&+ \frac{(\mu_A b_2 v z_2 - h_{A2})(S_{16} + S_{18} - b_1 S_{15})}{a_2 + a_3} \\
&+ \frac{(\mu_A b_3 v z_3 + h_{A3})(S_{16} + S_{18} - b_1 S_{15})}{a_2 + a_3}
\end{aligned} \tag{4.3.141}$$

$$\begin{aligned}
\sum F_y = 0 &= F_{A1y} - \sum_i \sum_j (F_{Rlij} + F_{Rrij}) \\
&= F_{A1y} - C_{12} \mu_B \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}| \\
&\quad - C_{13} \mu_B \sum_i \frac{A_i}{r_{Si}} \sum_j |x_{ij}|^2 \\
&= F_{A1y} - 2C_{12} S_{38} - 2C_{13} S_{37}
\end{aligned} \tag{4.3.145}$$

$$\frac{F_{A1y}}{\mu_B F_S} = \frac{S_{38}(S_3 - b S_2) + S_{37}(b S_4 - S_2)}{S_3 S_4 - S_2^2} \tag{4.3.146}$$

$$\begin{aligned}
\sum M_{A1} = 0 &= F_{A2x} (a_1 + a_2) \\
&+ \sum_i \sum_j F_{Rlij} (a_1 + |y_{ij}|) - \sum_i \sum_j (a_1 - |y_{ij}|) \\
&+ \sum_i \sum_j (F_{Rlij} + F_{Rrij}) (|x_{ij}| - b_1)
\end{aligned}$$

$$\begin{aligned}
&= F_{A2x} (a_2 + a_3) \\
&\quad + 2 C_{14} a_1 \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |y_{ij}|^2 \\
&\quad + 2 C_{12} \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |y_{ij}|^2 \\
&\quad + 2 C_{13} \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}| |y_{ij}|^2 \\
&\quad + 2 C_{12} \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}|^2 \\
&\quad + 2 C_{13} \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}|^3 \\
&\quad - 2 C_{12} b_1 \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}| \\
&\quad - 2 C_{13} b_1 \mu_B \sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}|^2
\end{aligned}$$

$$\begin{aligned}
&= F_{A2x} (a_1 + a_2) \\
&\quad + 2 C_{14} a_1 \mu_B S_{39} \\
&\quad + 2 C_{12} \mu_B S_{39} + 2 C_{13} \mu_B S_{40} \\
&\quad + 2 C_{12} \mu_B S_{37} + 2 C_{13} \mu_B S_{41} \\
&\quad - 2 C_{12} b_1 \mu_B S_{38} - 2 C_{13} b_1 \mu_B S_{37}
\end{aligned}$$

$$\begin{aligned}
&= F_{A2x} (a_1 + a_2) \\
&\quad - 2 C_{12} \mu_B (b_1 S_{38} - S_{37} - S_{39}) \\
&\quad - 2 C_{13} \mu_B (b_1 S_{37} - S_{40} - S_{41}) \\
&\quad + 2 C_{14} \mu_B a_1 S_{39}
\end{aligned}$$

(4.3.147)

$$\frac{F_{A2x}}{\mu_B F_S} = \frac{(S_3 - bS_2)(b_1 S_{38} - S_{37} - S_{39}) + (bS_4 - S_2)(b_1 S_{37} - S_{41} - S_{40})}{(a_1 + a_2)(S_3 S_4 - S_2^2)} - \frac{a a_1 S_{39}}{S_1 (a_1 + a_2)} \quad (4.3.148)$$

$$\begin{aligned} \Sigma F_x = 0 &= F_{A1x} - F_{A2x} - \Sigma_i \Sigma_j (F_{Rlij} - F_{Rrij}) \\ &= F_{A1x} - F_{A2x} - 2C_{14} \mu_B \Sigma_i \frac{A_i}{r_{Si}} \Sigma_j |y_{ij}|^2 \\ &= F_{A1x} - F_{A2x} - 2C_{14} \mu_B S_{39} \end{aligned} \quad (4.3.149)$$

$$\frac{F_{A1x}}{F_S \mu_B} = \frac{F_{A2x}}{F_S \mu_B} + a \frac{S_{39}}{S_1} \quad (4.3.150)$$

$$\begin{aligned} \Sigma F_y = 0 &= -F_{A1y} + \Sigma_i \Sigma_j (F_{Rlij} + F_{Rrij}) \\ &= -F_{A1y} - C_9 S_{19} - C_{10} S_{20} - C_{11} S_{22} + 2 S_{15} \end{aligned} \quad (4.3.154)$$

$$\begin{aligned} \Sigma M_{A1} = 0 &= -F_{A2x} (a_1 + a_2) \\ &\quad + \Sigma_i \Sigma_j (F_{Rlijy} + F_{Rrijy}) (b_1 - |x_{ij}|) \\ &\quad - \Sigma_i \Sigma_j [F_{Rlijx} (a_1 + |y_{ij}|) - F_{Rrijx} (a_1 - |y_{ij}|)] \\ &= -F_{A2x} (a_1 + a_2) \\ &\quad + b_1 \Sigma_i \Sigma_j (F_{Rlijy} + F_{Rrijy}) \end{aligned}$$

$$\begin{aligned}
& -\sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) |x_{ij}| \\
& -a_1 \sum_i \sum_j (F_{Rlijx} - F_{Rrijx}) \\
& -\sum_i \sum_j (F_{Rlijx} + F_{Rrijx}) |y_{ij}| \\
& = -FA_{2x} (a_1 + a_2) \\
& \quad + 2b_1 S_{15} \\
& \quad - C_9 b_1 S_{19} - C_{10} b_1 S_{20} - C_{11} b_1 S_{22} \\
& \quad - 2S_{16} \\
& \quad + C_9 S_{20} + C_{10} S_{21} + C_{11} S_{23} \\
& \quad + C_9 S_{25} a_1 + C_{10} S_{22} a_1 + C_{11} S_{26} a_1 \\
& \quad - 2S_{18} \\
& \quad + C_9 S_{26} + C_{10} S_{24} + C_{11} S_{27}
\end{aligned} \tag{4.3.156}$$

$$\begin{aligned}
\Sigma F_x = 0 &= -FA_{1x} + FA_{2x} + \sum_i \sum_j (F_{Rlijx} - F_{Rrijx}) \\
&= -FA_{1x} + FA_{2x} - C_9 S_{25} - C_{10} S_{22} - C_{11} S_{26}
\end{aligned} \tag{4.3.158}$$

$$\begin{aligned}
\Sigma F_z = 0 &= F_S - \mu_A (FA_{1y} + v z_1 k_1 FA_{1x} + v z_2 FA_{2x}) \\
& \quad - \sum_i \sum_j (F_{Nlij} + F_{Nrjij}) \\
&= F_S - \mu_A (FA_{1y} + v z_1 k_1 FA_{1x} + v z_2 FA_{2x}) \\
& \quad + C_9 S_{28} + C_{10} S_{29} + C_{11} S_{30} - 2S_{31}
\end{aligned} \tag{4.3.160}$$

$$\begin{aligned}
\Sigma M_x = 0 &= F_S a - F_{A1y} h_{A1} \\
&+ \mu_A (a_1 F_{A1y} + a_1 F_{A1x} v_{z1} k_1 - a_2 F_{A2x} v_{z2}) \\
&- \sum_i \sum_j (F_{Nlij} - F_{Nr_{ij}}) |y_{ij}| \\
&= F_S a - F_{A1y} h_{A1} \\
&+ \mu_A (a_1 F_{A1y} + a_1 F_{A1x} v_{z1} k_1 - a_2 F_{A2x} v_{z2}) \\
&+ C_9 S_{30} + C_{10} S_{33} + C_{11} S_{34} \qquad (4.3.162)
\end{aligned}$$

$$\begin{aligned}
\Sigma M_y = 0 &= F_S b - F_{A1y} \mu_A b_1 \\
&- F_{A1x} (\mu_A b_1 v_{z1} k_1 - h_{A1}) \\
&- F_{A2x} (\mu_A b_2 v_{z2} + h_{A2}) \\
&- \sum_i \sum_j (F_{Nlij} + F_{Nr_{ij}}) |x_{ij}| \\
&= F_S b - F_{A1y} \mu_A b_1 \\
&- F_{A1x} (\mu_A b_1 v_{z1} k_1 - h_{A1}) \\
&- F_{A2x} (\mu_A b_2 v_{z2} + h_{A2}) \\
&+ C_9 S_{29} + C_{10} S_{35} + C_{11} S_{33} - 2S_{36} \qquad (4.3.164)
\end{aligned}$$

$$\begin{aligned}
Ch_1 &= S_{28} + \mu_A (S_{19} + v_{z1} k_1 S_{25}) \\
&- \mu_A \frac{(v_{z1} k_1 + v_{z1})(b_1 S_{19} - a_1 S_{25} - S_{20} - S_{26})}{a_1 + a_2} \qquad (4.4.166)
\end{aligned}$$

$$C_{h2} = S_{29} + \mu_A (S_{20} + v_{z1} k_1 S_{22}) + \mu_A \frac{(v_{z1} k_1 + v_{z2})(b_1 S_{20} - a_1 S_{22} - S_{21} - S_{24})}{a_1 + a_2} \quad (4.3.167)$$

$$C_{h3} = S_{30} + \mu_A (S_{22} + v_{z1} k_1 S_{26}) + \mu_A \frac{(v_{z1} k_1 + v_{z2})(b_1 S_{22} - a_1 S_{26} - S_{23} - S_{27})}{a_1 + a_2} \quad (4.3.168)$$

$$C_{h4} = 2 \left[S_{31} + \mu_A S_{15} + \mu_A \frac{(v_{z1} k_1 + v_{z2})(b_1 S_{15} - S_{16} - S_{18})}{a_1 + a_2} \right] - F_S \quad (4.3.169)$$

$$C_{h5} = S_{30} + h_{A1} S_{19} - \mu_A a_1 (S_{19} + v_{z1} k_1 S_{25}) - \mu_A \frac{(a_1 v_{z1} k_1 - a_2 v_{z2})(b_1 S_{19} - a_1 S_{25} - S_{20} - S_{26})}{a_1 + a_2} \quad (4.3.170)$$

$$C_{h6} = S_{33} + h_{A1} S_{20} - \mu_A a_1 (S_{20} + v_{z1} k_1 S_{25}) - \mu_A \frac{(a_1 v_{z1} k_1 - a_2 v_{z2})(b_1 S_{20} - a_1 S_{22} - S_{21} - S_{24})}{a_1 + a_2} \quad (4.3.171)$$

$$C_{h7} = S_{34} + h_{A1} S_{22} - \mu_A a_1 (S_{22} + v_{z1} k_1 S_{26}) - \mu_A \frac{(a_1 v_{z1} k_1 - a_2 v_{z2})(b_1 S_{22} - a_1 S_{26} - S_{23} - S_{27})}{a_1 + a_2} \quad (4.3.172)$$

$$C_{h8} = 2 (h_{A1} S_{15} - \mu_A a_1 S_{15}) - F_S a - \mu_A \frac{(a_1 v_{z1} k_1 - a_2 v_{z2})(b_1 S_{15} - S_{16} - S_{18})}{a_1 + a_2} \quad (4.3.173)$$

$$C_{h9} = S_{29} + \mu_{Ab1} S_{19} + (\mu_{Ab1} v z_1 k_1 - h_{A1}) S_{25} \\ + \frac{(\mu_{Ab1} v z_1 k_1 - h_{A1} + \mu_{Ab2} v z_2 + h_{A2})(b_1 S_{19} - a_1 S_{25} - S_{20} - S_{26})}{a_1 + a_2} \quad (4.3.174)$$

$$C_{h10} = S_{35} + \mu_{Ab1} S_{20} + (\mu_{Ab1} v z_1 k_1 - h_{A1}) S_{22} \\ + \frac{(\mu_{Ab1} v z_1 k_1 - h_{A1} + \mu_{Ab2} v z_2 + h_{A2})(b_1 S_{20} - a_1 S_{22} - S_{21} - S_{24})}{a_1 + a_2} \quad (4.3.175)$$

$$C_{h11} = S_{33} + \mu_{Ab1} S_{22} + (\mu_{Ab1} v z_1 k_1 - h_{A1}) S_{26} \\ + \frac{(\mu_{Ab1} v z_1 k_1 - h_{A1} + \mu_{Ab2} v z_2 + h_{A2})(b S_{22} - a_1 S_{26} - S_{23} - S_{27})}{a_1 + a_2} \quad (4.3.176)$$

$$C_{h12} = 2(S_{36} + \mu_{Ab1} S_{15}) - F_S b \\ + \frac{(\mu_{Ab1} v z_1 k_1 - h_{A1} + \mu_{Ab2} v z_2 + h_{A2})(b_2 S_{15} - S_{16} - S_{18})}{a_1 + a_2} \quad (4.3.177)$$

$$\Sigma M_{A2} = 0 = -F_{A1y}(b_1 - b_2)$$

$$\begin{aligned} & -\sum_i \sum_j [F_{Rlijx}(a_1 - |y_{ij}|) - F_{Rrijx}(a_1 + |y_{ij}|)] \\ & + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy})(|x_{ij}| - b_2) \\ & = -F_{A1y}(b_1 - b_2) \end{aligned}$$

$$\begin{aligned} & -2C_{14}\alpha_1 \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |y_{ij}|^2 \\ & + 2C_{12} \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |y_{ij}|^2 \\ & + 2C_{13} \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |x_{ij}| |y_{ij}|^2 \\ & + 2C_{12} \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |x_{ij}|^2 \\ & + 2C_{13} \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |x_{ij}|^3 \\ & - 2C_{12} b_2 \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |x_{ij}| \\ & - 2C_{13} b_2 \sum_i \frac{A_i \mu_i}{r_{S_i}} \sum_j |x_{ij}|^2 \end{aligned}$$

$$= -F_{A1y}(b_1 - b_2) - 2C_{14}\alpha_1 S_8$$

$$+ 2C_{12} S_8 + 2C_{13} S_{14}$$

$$+ 2C_{12} S_7 + 2C_{13} S_{13}$$

$$- 2C_{12} S_6 - 2C_{13} S_7$$

(4.4.11)

$$\Sigma M_{A1} = 0 = F_{A2y}(b_1 - b_2)$$

$$\begin{aligned} & - \sum_i \sum_j [F_{RLijx}(a_1 - |y_{ij}|) - F_{Rrijx}(a_1 + |y_{ij}|)] \\ & + \sum_i \sum_j (F_{RLijy} + F_{Rrijy})(|x_{ij}| - b_1) \\ & = F_{A2y}(b_1 - b_2) \end{aligned}$$

$$-2C_{14}a_1S_8$$

$$+2C_{12}S_8 + 2C_{13}S_{14}$$

$$+2C_{12}S_7 + 2C_{13}S_{13}$$

$$-2C_{12}b_2S_6 - 2C_{13}b_2S_7$$

(4.4.13)

$$\Sigma F_z = 0 = F_s - \mu_A(F_{A1y} + F_{A2y})$$

$$- \sum_i \sum_j (F_{Nlij} + F_{Nrjij})$$

$$= F_s - \mu_A(F_{A1y} + F_{A2y})$$

$$- 2C_{12} \sum_i A_i \sum_j 1$$

$$- 2C_{13} \sum_i A_i \sum_j |x_{ij}|$$

$$= \frac{F_s}{2} - \mu_A C_{12} S_6 - \mu_A C_{13} S_7$$

$$- C_{12} S_4 - C_{13} S_2$$

(4.4.15)

$$\begin{aligned}
\Sigma M_x = 0 &= F_S a - h_A (F_{A1y} + F_{A2y}) - \mu_A a_1 (F_{A1y} + F_{A2y}) \\
&\quad - \sum_i \sum_j (F_{Nlij} - F_{Nr ij}) |y_{ij}| \\
&= F_S a - (h_A + \mu_A a_1) (F_{A1y} + F_{A2y}) \\
&\quad - 2C_{14} \sum_i A_i \sum_j |y_{ij}|^2 \\
&= F_S a - 2C_{12} S_6 (h_A + \mu_A a_1) \\
&\quad - 2C_{13} S_7 (h_A + \mu_A a_1) \\
&\quad - 2C_{14} S_1
\end{aligned} \tag{4.4.17}$$

$$\begin{aligned}
\Sigma M_y = 0 &= F_S b - \mu_A (F_{A1y} b_1 + F_{A2y} b_2) \\
&\quad - \sum_i \sum_j (F_{Nlij} + F_{Nr ij}) |x_{ij}| \\
&= F_S b - \mu_A (F_{A1y} b_1 + F_{A2y} b_2) \\
&\quad - 2C_{12} \sum_i A_i \sum_j |x_{ij}| \\
&\quad - 2C_{13} \sum_i A_i \sum_j |x_{ij}|^2 \\
&= F_S b - 2C_{12} \mu_A (S_7 + S_8) - 2C_{13} \mu_A (S_{13} + S_{14}) \\
&\quad + 2C_{14} a_1 \mu_A S_8 \\
&\quad - 2C_{12} S_2 - 2C_{13} S_3
\end{aligned} \tag{4.4.19}$$

$$C_{h1} = \mu_A S_6 + S_4 \quad (4.4.21)$$

$$C_{h2} = \mu_A S_7 + S_2 \quad (4.4.22)$$

$$C_{h3} = 0 \quad (4.4.23)$$

$$C_{h4} = \frac{F_S}{2} \quad (4.4.24)$$

$$C_{h5} = S_6 (h_A + \mu_A a_1) \quad (4.4.25)$$

$$C_{h6} = S_7 (h_A + \mu_A a_1) \quad (4.4.26)$$

$$C_{h7} = S_1 \quad (4.4.27)$$

$$C_{h8} = F_S \frac{a}{2} \quad (4.4.28)$$

$$C_{h9} = \mu_A (S_7 + S_8) + S_2 \quad (4.4.29)$$

$$C_{h10} = \mu_A (S_{13} + S_{14}) + S_3 \quad (4.4.30)$$

$$C_{h11} = -\mu_A a_1 S_8 \quad (4.4.31)$$

$$C_{h12} = F_S \frac{b}{2} \quad (4.4.32)$$

$$\begin{aligned} \sum F_y = 0 &= -F_{A1y} + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ &= -F_{A1y} + 2C_{12} \sum_i \frac{A_i \mu_A}{r_{Si}} \sum_j |x_{ij}| + 2C_{13} \sum_i \frac{A_i \mu_i}{r_{Si}} \sum_j |x_{ij}|^2 \\ &= -F_{A1y} + 2C_{12} S_6 + 2C_{13} S_7 \end{aligned} \quad (4.4.33)$$

$$\Sigma M_{A3} = 0 = -F_{A2x}(a_2 + a_3) + F_{A1y}(b_3 - b_1)$$

$$+ \sum_i \sum_j (F_{Rlijy} + F_{Rrijy})(x_{ij} - b_3)$$

$$+ \sum_i \sum_j [F_{Rlijx}(a_3 + |y_{ij}|) - F_{Rrijx}(a_3 - |y_{ij}|)]$$

$$= -F_{A2x}(a_2 + a_3) + F_{A1y}(b_3 - b_1)$$

$$+ \sum_i \sum_j (F_{Rlijy} + F_{Rrijy})|x_{ij}|$$

$$- b_3 \sum_i \sum_j (F_{Rlijy} + F_{Rrijy})$$

$$+ a_3 \sum_i \sum_j (F_{Rlijx} - F_{Rrijx})$$

$$+ \sum_i \sum_j (F_{Rlijx} + F_{Rrijx})|y_{ij}|$$

$$= -F_{A2x}(a_2 + a_3)$$

$$+ 2C_{12}b_3S_6 + 2C_{13}b_3S_7$$

$$- 2C_{12}b_1S_6 - 2C_{13}b_1S_7$$

$$+ 2C_{12}S_7 + 2C_{13}S_{13}$$

$$- 2C_{12}b_3S_6 - 2C_{13}b_3S_7$$

$$+ 2C_{14}a_3S_8$$

$$+ 2C_{12}S_8 + 2C_{13}S_{14}$$

(4.4.35)

$$\begin{aligned}\Sigma F_x = 0 &= -F_{A3x} + F_{A2x} - \sum_i \sum_j (F_{Rlijx} - F_{Rrijx}) \\ &= -F_{A3x} + F_{A2x} - 2C_{14} S_8\end{aligned}\quad (4.4.37)$$

$$\begin{aligned}\Sigma F_z = 0 &= F_S - \mu_A (F_{A1y} + F_{A2x} v_{z2} + F_{A3x} v_{z3}) \\ &\quad - \sum_i \sum_j (F_{Mlij} + F_{Nrjij}) \\ &= -F_S + \mu_A (F_{A1y} + F_{A2y} v_{z2} + F_{A3} v_{z3}) \\ &\quad + 2C_{12} S_4 + 2C_{13} S_2\end{aligned}\quad (4.4.39)$$

$$\begin{aligned}\Sigma M_x = 0 &= F_S a - F_{A1y} (h_A + \mu_A a_1) \\ &\quad - \mu_A (F_{A2x} v_{z2} a_2 - F_{A3x} v_{z3} a_3) \\ &\quad - \sum_i \sum_j (F_{Mlij} - F_{Nrjij}) |y_{ij}| \\ &= -F_S \frac{a}{2} \\ &\quad + C_{12} S_6 (h_A + \mu_A a_1) + C_{13} S_7 (h_A + \mu_A a_1) \\ &\quad - C_{12} \mu_A \frac{(v_{z2} a_2 - v_{z3} a_3) (b_1 S_6 - S_7 - S_8)}{a_2 + a_3} \\ &\quad - C_{13} \mu_A \frac{(v_{z2} a_2 - v_{z3} a_3) (b_1 S_7 - S_{13} - S_{14})}{a_2 + a_3} \\ &\quad + C_{14} \mu_A S_8 a_2 a_3 \frac{v_{z2} - v_{z3}}{a_2 + a_3} + C_{14} S_1\end{aligned}\quad (4.4.41)$$

$$\begin{aligned}
\Sigma M_y = 0 &= -F_S b + F_{A1y} \mu_A b_1 - h_A (F_{A2x} - F_{A3x}) \\
&+ \mu_A (F_{A2x} v_{z2} b_2 + F_{A3x} v_{z3} b_3) \\
&+ \sum_i \sum_j (F_{Nl_{ij}} + F_{Nr_{ij}}) |x_{ij}| \\
&= -F_S \frac{b}{2} + C_{12} \mu_A b_1 S_6 + C_{13} \mu_A b_1 S_7 - C_{14} h_A S_8 \\
&\quad - C_{12} \mu_A \frac{(v_{z2} b_2 + v_{z3} b_3)(b_1 S_6 - S_7 - S_8)}{a_2 + a_3} \\
&\quad - C_{13} \mu_A \frac{(v_{z2} b_2 + v_{z3} b_3)(b_1 S_7 - S_{13} - S_{14})}{a_2 + a_3} \\
&\quad + C_{14} \mu_A S_8 \frac{v_{z2} b_2 a_3 - v_{z3} b_3 a_2}{a_2 + a_3} \\
&\quad + C_{12} S_2 + C_{13} S_3 \tag{4.4.43}
\end{aligned}$$

$$C_{h1} = S_4 + \mu_A S_6 - \mu_A \frac{(v_{z1} + v_{z2})(b_1 S_6 - S_7 - S_8)}{a_2 + a_3} \tag{4.4.45}$$

$$C_{h2} = S_2 + \mu_A S_7 - \mu_A \frac{(v_{z1} + v_{z2})(b_1 S_7 - S_{13} - S_{14})}{a_2 + a_3} \tag{4.4.46}$$

$$C_{h3} = \mu_A S_8 \frac{v_{z2} a_3 - v_{z3} a_2}{a_2 + a_3} \tag{4.4.47}$$

$$C_{h4} = \frac{F_S}{2} \tag{4.4.48}$$

$$C_{h5} = S_6 (h_A + \mu_A a_1) - \mu_A \frac{(v_{z2} a_2 - v_{z3} a_3)(b_1 S_6 - S_7 - S_8)}{a_2 + a_3} \tag{4.4.49}$$

$$C_{h6} = S_7(h_A + \mu_A a_1) - \mu_A \frac{(v_{z2} a_2 - v_{z3} a_3)(b_1 S_7 - S_{13} - S_{14})}{a_2 + a_3} \quad (4.4.50)$$

$$C_{h7} = S_1 + \mu_A S_8 a_2 a_3 \frac{v_{z2} - v_{z3}}{a_2 + a_3} \quad (4.4.51)$$

$$C_{h8} = F_S \frac{a}{2} \quad (4.4.52)$$

$$C_{h9} = S_2 + \mu_A b_1 S_6 - \mu_A \frac{(v_{z2} b_2 + v_{z3} b_3)(b_1 S_6 - S_7 - S_8)}{a_2 + a_3} \quad (4.4.53)$$

$$C_{h10} = S_3 + \mu_A b_1 S_7 - \mu_A \frac{(v_{z2} b_2 + v_{z3} b_3)(b_1 S_7 - S_{13} - S_{14})}{a_2 + a_3} \quad (4.4.54)$$

$$C_{h11} = \mu_A S_8 \frac{v_{z2} b_2 a_3 - v_{z3} b_3 a_2}{a_2 + a_3} - h_A S_8 \quad (4.4.55)$$

$$C_{h12} = F_S \frac{b}{2} \quad (4.4.56)$$

$$\begin{aligned} \sum F_y = 0 &= -F_{A1y} + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ &= -F_{A1y} + 2C_{12} S_6 + 2C_{13} S_7 \end{aligned} \quad (4.4.57)$$

$$\begin{aligned} \sum M_{A1y} = 0 &= -F_{A2x} (a_1 + a_2) + b_1 \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ &\quad - \sum_i \sum_j [F_{Rlijx} (a_1 + |y_{ij}|) - F_{Rrijx} (a_1 - |y_{ij}|)] \\ &= -F_{A2x} (a_1 + a_2) + b_1 \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ &\quad - \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) |x_{ij}| \end{aligned}$$

$$-a_1 \sum_i \sum_j (F_{Rlijx} - F_{Rrijx})$$

$$- \sum_i \sum_j (F_{Rlijx} + F_{Rrijx}) |y_{ij}|$$

$$\begin{aligned} &= -F_{A2x}(a_1 + a_2) \\ &\quad + 2C_{12}b_1S_6 + 2C_{13}b_1S_7 \\ &\quad - 2C_{12}S_7 - 2C_{13}S_{13} \\ &\quad - 2C_{14}a_1S_8 \\ &\quad - 2C_{12}S_8 - 2C_{13}S_{14} \end{aligned}$$

(4.4.59)

$$\sum F_x = 0 = -F_{A1x} + F_{A2x} + \sum_i \sum_j (F_{Rlijx} - F_{Rrijx})$$

$$= -F_{A1x} + F_{A2x} + 2C_{14}S_8$$

(4.4.61)

$$\sum F_z = 0 = F_S - \mu_A (F_{A1y} + F_{A1x}vz_1k_1 + F_{A2x}vz_2)$$

$$- \sum_i \sum_j (F_{Nlij} + F_{Nrij})$$

$$= -F_S + \mu_A (F_{A1y} + F_{A1x}vz_1k_1 + F_{A2x}vz_2)$$

$$+ 2C_{12}S_4 + 2C_{13}S_2$$

(4.4.63)

$$\sum M_x = 0 = F_S a - F_{A1y} (h_A - \mu_A a_1)$$

$$+ \mu_A (F_{A1x}vz_1k_1 a_1 - F_{A1x}vz_2 a_2)$$

$$\begin{aligned}
& -\sum_i \sum_j (F_{N_{ij}} - F_{r_{ij}}) |y_{ij}| \\
& = -F_S a + F_{A1y} (h_A - \mu_A a_1) \\
& \quad - \mu_A (F_{A1x} v_{z1} k_1 a_1 - F_{A2x} v_{z2} a_2) \\
& \quad + 2C_{14} S_1
\end{aligned} \tag{4.4.65}$$

$$\begin{aligned}
\Sigma M_y = 0 & = F_S b - \mu_A F_{A1y} b_1 + h_A (F_{A1x} - F_{A2x}) \\
& \quad - \mu_A (F_{A1x} v_{z1} k_1 b_1 + F_{A2x} v_{z2} b_2) \\
& \quad - \sum_i \sum_j (F_{N_{ij}} + F_{r_{ij}}) |x_{ij}| \\
& = -F_S b + \mu_A F_{A1y} b_1 - h_A (F_{A1x} - F_{A2x}) \\
& \quad + \mu_A (F_{A1x} v_{z1} k_1 b_1 + F_{A2x} v_{z2} b_2) \\
& \quad + 2C_{12} S_2 + 2C_{13} S_3
\end{aligned} \tag{4.4.67}$$

$$C_{h1} = S_4 + \mu_A S_6 + \mu_A \frac{(v_{z1} k_1 + v_{z2})(b_1 S_6 - S_7 - S_8)}{a_1 + a_2} \tag{4.4.69}$$

$$C_{h2} = S_2 + \mu_A S_7 + \mu_A \frac{(v_{z1} k_1 + v_{z2})(b_1 S_7 - S_{13} - S_{14})}{a_1 + a_2} \tag{4.4.70}$$

$$C_{h3} = \mu_A S_8 \frac{(v_{z1} k_1 a_2 - v_{z2} a_1)}{a_1 + a_2} \tag{4.4.71}$$

$$C_{h4} = \frac{F_S}{2} \tag{4.4.72}$$

$$C_{h5} = (h_A - \mu_A a_1) S_6 - \mu_A \frac{(v_{z1} k_1 a_1 - v_{z2} a_2)(b_1 S_6 - S_7 - S_8)}{a_1 + a_2} \quad (4.4.73)$$

$$C_{h6} = (h_A - \mu_A a_1) S_7 - \mu_A \frac{(v_{z1} k_1 a_1 - v_{z2} a_2)(b_1 S_7 - S_{13} - S_{14})}{a_1 + a_2} \quad (4.4.74)$$

$$C_{h7} = S_1 - \mu_A a_1 a_2 S_8 \frac{v_{z1} k_1 + v_{z2}}{a_1 + a_2} \quad (4.4.75)$$

$$C_{h8} = F_S \frac{a}{2} \quad (4.4.76)$$

$$C_{h9} = S_2 + \mu_A b_1 S_6 + \mu_A \frac{(v_{z1} k_1 b_1 + v_{z2} b_2)(b_1 S_6 - S_7 - S_8)}{a_1 + a_2} \quad (4.4.77)$$

$$C_{h10} = S_3 + \mu_A b_2 S_7 + \mu_A \frac{(v_{z1} k_1 b_1 + v_{z2} b_2)(b_1 S_7 - S_{13} - S_{14})}{a_1 + a_2} \quad (4.4.78)$$

$$C_{h11} = S_8 \left(\mu_A \frac{v_{z1} k_1 a_2 b_1 - v_{z2} a_1 b_2}{a_1 + a_2} - h_A \right) \quad (4.4.79)$$

$$C_{h12} = F_S \frac{b}{2} \quad (4.4.80)$$

$$\Sigma M_{A2} = 0 = -F_{A1y}(b_1 - b_2)$$

$$- \sum_i \sum_j (F_{Rlijy} + F_{Rrijy})(b_2 - |x_{ij}|)$$

$$- \sum_i \sum_j [F_{Rlijx}(a_1 - |y_{ij}|) - F_{Rrijx}(a_1 + |y_{ij}|)]$$

$$= -F_{A1y}(b_1 - b_2)$$

$$- 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}^2} \sum_j (b_2 - |x_{ij}|) |x_{ij}|$$

$$+ 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |y_{ij}|^2$$

(4.5.1)

$$S_{48} = \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |y_{ij}|^2$$

(4.5.2)

$$S_{49} = \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |x_{ij}|^2$$

(4.5.3)

$$\Sigma M_{A1} = 0 = -F_{A2y}(b_1 - b_2)$$

$$+ \sum_i \sum_j (F_{Rlijy} + F_{Rrijy})(b_1 - |x_{ij}|)$$

$$+ \sum_i \sum_j [F_{Rlijx}(a_1 - |y_{ij}|) - F_{Rrijx}(a_1 + |y_{ij}|)]$$

$$= -F_{A2y}(b_1 - b_2)$$

$$+ 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}^2} \sum_j (b_1 - |x_{ij}|) |x_{ij}|$$

$$- 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |y_{ij}|^2$$

(4.5.5)

$$\begin{aligned}
\Sigma F_z = 0 &= F_S - \mu_A (F_{A1y} + F_{A2y}) \\
&\quad - \sum_i \sum_j (F_{M_{ij}} + F_{N_{ij}}) \\
&= F_S - 2P_{RBmspez} \mu_A S_{46} \\
&\quad - 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i} \mu_i} \sum_j 1 \\
&= F_S - 2P_{RBmspez} (\mu_A S_{46} + S_{45}) \tag{4.5.7}
\end{aligned}$$

$$\begin{aligned}
\Sigma M_x = 0 &= F_S a_c - (F_{A1y} + F_{A2y})(h_A + \mu_A a_1) \\
&\quad - \sum_i \sum_j (F_{M_{ij}} - F_{N_{ij}}) |y_{ij}| \\
&= F_S a_c - 2P_{RBmspez} S_{46} (h_A + \mu_A a_1) \tag{4.5.9}
\end{aligned}$$

$$\begin{aligned}
\Sigma M_y = 0 &= F_S b_c - \mu_A (F_{A1y} b_1 + F_{A2y} b_2) \\
&\quad - \sum_i \sum_j (F_{M_{ij}} + F_{N_{ij}}) |x_{ij}| \\
&= F_S b_c - 2P_{RBmspez} \mu_A (S_{49} + S_{48}) \\
&\quad - 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i} \mu_i} \sum_j |x_{ij}| \\
&= F_S b_c - 2P_{RBmspez} [\mu_A (S_{49} + S_{48}) + S_{47}] \tag{4.5.11}
\end{aligned}$$

$$\begin{aligned}\sum F_y = 0 &= -F_{A1y} + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\ &= -F_{A1y} + 2 P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |x_{ij}| \end{aligned} \quad (4.5.13)$$

$$\begin{aligned}\sum M_{A3} = 0 &= -F_{A2x} (a_2 + a_3) + F_{A1y} (b_3 - b_1) \\ &\quad + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) (|x_{ij}| - b_3) \\ &\quad + \sum_i \sum_j [F_{Rlijx} (a_3 + |y_{ij}|) - F_{Rrijx} (a_3 - |y_{ij}|)] \\ &= -F_{A2x} (a_2 + a_3) \\ &\quad + 2 P_{RBmspez} S_{46} (b_3 - b_1) \\ &\quad + 2 P_{RBmspez} \left(\sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}|^2 - b_3 \sum_i \frac{A_i}{r_{S_i}} \sum_j |x_{ij}| \right) \\ &\quad + 2 P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}} \sum_j |y_{ij}|^2 \\ &= -F_{A2x} (a_2 + a_3) \\ &\quad + 2 P_{RBmspez} (S_{49} + S_{48} - b_1 S_{46}) \end{aligned} \quad (4.5.15)$$

$$\begin{aligned}\sum F_x = 0 &= -F_{A3x} + F_{A2x} - \sum_i \sum_j (F_{Rlijx} - F_{Rrijx}) \\ &= -F_{A3x} + F_{A2x} \end{aligned} \quad (4.5.17)$$

$$\begin{aligned}
\Sigma F_z = 0 &= F_S - \mu_A (F_{A1y} + F_{A2x} v_{z2} + F_{A3x} v_{z3}) \\
&\quad - \sum_i \sum_j (F_{Nlij} + F_{Nr_{ij}}) \\
&= F_S - 2P_{RBmspez} \mu_A \left[S_{46} + \frac{(v_{z2} + v_{z3})(S_{49} + S_{48} - b_1 S_{46})}{a_2 + a_3} \right] \\
&\quad - 2P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}} \mu_i \sum_j 1
\end{aligned} \tag{4.5.19}$$

$$\begin{aligned}
\Sigma M_y = 0 &= -F_S a_C + F_{A1y} (h_A + \mu_A a_1) \\
&\quad + \mu_A (F_{A2x} v_{z2} a_2 - F_{A3x} v_{z3} a_3) \\
&\quad + \sum_i \sum_j (F_{Nlij} - F_{Nr_{ij}}) |y_{ij}| \\
&= -F_S a_C + 2P_{RBmspez} \left[(h_A + \mu_A a_1) S_{46} \right. \\
&\quad \left. + \mu_A \frac{(v_{z2} a_2 - v_{z3} a_3)(S_{49} + S_{48} - b_1 S_{46})}{a_2 + a_3} \right]
\end{aligned} \tag{4.5.21}$$

$$\begin{aligned}
\Sigma M_x = 0 &= -F_S a_C + F_{A1y} \mu_A b_1 \\
&\quad - h_A (F_{A2x} - F_{A3x}) + \mu_A (F_{A2x} v_{z2} b_2 + F_{A3x} v_{z3} b_3) \\
&\quad + \sum_i \sum_j (F_{Nlij} + F_{Nr_{ij}}) |x_{ij}| \\
&= -F_S a_C + 2P_{RBmspez} \mu_A b_1 S_{46}
\end{aligned}$$

$$\begin{aligned}
& + 2 P_{RBmspez} \mu_A \frac{vz_2 b_2 + vz_3 b_3}{a_2 + a_3} (S_{49} + S_{48} - b_1 S_{46}) \\
& + 2 P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}} \mu_i \sum_j |x_{ij}| \\
& = -F_S b_C + 2 P_{RBmspez} [S_{47} + \mu_A b_1 S_{46} \\
& \quad + \mu_A \frac{vz_2 b_2 + vz_3 b_3}{a_2 + a_3} (S_{49} + S_{48} - b_1 S_{46})] \quad (4.5.23)
\end{aligned}$$

$$\begin{aligned}
\Sigma F_y = 0 & = -F_{A1y} + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) \\
& = -F_{A1y} + 2 P_{RBmspez} \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |x_{ij}| \quad (4.5.25)
\end{aligned}$$

$$\begin{aligned}
\Sigma M_{A1} = 0 & = -F_{A2x} (a_1 + a_2) + \sum_i \sum_j (F_{Rlijy} + F_{Rrijy}) (b_1 - |x_{ij}|) \\
& \quad - \sum_i \sum_j [F_{Rlijx} (a_1 + |y_{ij}|) - F_{Rrijx} (a_1 + |y_{ij}|)] \\
& = -F_{A2x} (a_1 + a_2) \\
& \quad + 2 P_{RBmspez} (b_1 \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |x_{ij}| - \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |x_{ij}| \\
& \quad \quad \quad - \sum_i \frac{A_i}{r_{S_i}^2} \sum_j |y_{ij}|^2) \quad (4.5.27)
\end{aligned}$$

$$\begin{aligned}
\Sigma F_x = 0 & = -F_{A1x} + F_{A2x} + \sum_i \sum_j (F_{Rlijx} + F_{Rrijx}) \\
& = -F_{A1x} + F_{A2x} \quad (4.5.29)
\end{aligned}$$

$$\begin{aligned}
\Sigma F_z = 0 &= F_S - \mu_A (F_{A1y} + F_{A1x} v_{z1} k_1 + F_{A2x} v_{z2}) \\
&\quad - \Sigma_i \Sigma_j (F_{Nlij} F_{Nrjij}) \\
&= F_S - 2 P_{RBmspez} \mu_A \left[S_{46} + \frac{(v_{z1} k_1 + v_{z2})(b_1 S_{46} - S_{49} - S_{48})}{a_1 + a_2} \right] \\
&\quad - 2 P_{RBmspez} \Sigma_i \frac{A_i}{r_{s_i} \mu_i} \Sigma_j 1 \tag{4.5.31}
\end{aligned}$$

$$\begin{aligned}
\Sigma M_x = 0 &= -F_S a_c + F_{A1y} (h_A - \mu_A a_1) \\
&\quad - \mu_A (F_{A1x} v_{z1} k_1 a_1 - F_{A2x} v_{z2} a_2) \\
&\quad + \Sigma_i \Sigma_j (F_{Nlij} - F_{Nrjij}) |y_{ij}| \\
&= -F_S a_c + 2 P_{RBmspez} \left[(h_A - \mu_A a_1) S_{46} \right. \\
&\quad \left. - \mu_A \frac{v_{z1} k_1 a_1 - v_{z2} a_2}{a_1 + a_2} (b_1 S_{46} - S_{49} - S_{48}) \right] \tag{4.5.33}
\end{aligned}$$

$$\begin{aligned}
\Sigma M_y = 0 &= -F_S b_c + F_{A1y} \mu_A b_1 - (F_{A1x} - F_{A2x}) h_A \\
&\quad + \mu_A (F_{A1x} v_{z1} k_1 b_1 + F_{A2x} v_{z2} b_2) \\
&\quad + \Sigma_i \Sigma_j (F_{Nlij} + F_{Nrjij}) |x_{ij}| \\
&= -F_S b_c + 2 P_{RBmspez} \mu_A \left[b_1 S_{46} \right. \\
&\quad \left. + \frac{v_{z1} k_1 b_1 + v_{z2} b_2}{a_1 + a_2} (b_1 S_{46} - S_{49} - S_{48}) \right]
\end{aligned}$$

$$+ 2 P_{RBmspez} \sum_i \frac{A_i}{r_{S_i} \mu_i} \sum_j |x_{ij}|$$

$$= -F_S b_C + 2 P_{RBmspez} \left[S_{47} + \mu_A b_1 S_{46} + \mu_A \frac{v_{z1} k_1 b_1 + v_{z2} b_2}{a_1 + a_2} (b_1 S_{46} - S_{49} - S_{48}) \right] \quad (4.5.35)$$