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پیوست:

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$$
\begin{aligned}
&\delta u: a_{11}\frac{\partial^2 u}{\partial x^2}+b_{11}\frac{\partial^2\psi_x}{\partial x^2}+a_{12}\frac{1}{R}\left(\frac{\partial^2 v}{\partial x\partial\theta}+\frac{\partial w}{\partial x}\right)+\frac{b_{12}}{R}\frac{\partial^2\psi_\theta}{\partial x\partial\theta}+\\
&f_{31}\frac{\partial\phi_{in}}{\partial x}+\bar{f}_{31}\frac{\partial\phi_{ex}}{\partial x}+\frac{a_{66}}{R}\left(\frac{\partial^2 v}{\partial x\partial\theta}+\frac{1}{R}\frac{\partial^2 u}{\partial\theta^2}\right)+\\
&\frac{b_{66}}{R}\left(\frac{\partial^2\psi_\theta}{\partial x\partial\theta}+\frac{1}{R}\frac{\partial^2\psi_x}{\partial\theta^2}\right)=I_0\frac{\partial^2 u}{\partial t^2}+I_1\frac{\partial^2\psi_x}{\partial t^2},\\
&\delta v: a_{66}\left(\frac{\partial^2 v}{\partial x^2}+\frac{1}{R}\frac{\partial^2 u}{\partial x\partial\theta}\right)+b_{66}\left(\frac{\partial^2\psi_\theta}{\partial x^2}+\frac{1}{R}\frac{\partial^2\psi_x}{\partial x\partial\theta}\right)+\\
&\frac{a_{12}}{R}\frac{\partial^2 u}{\partial x\partial\theta}+\frac{b_{12}}{R}\frac{\partial^2\psi_x}{\partial x\partial\theta}+\frac{a_{22}}{R}\frac{1}{R}\left(\frac{\partial^2 v}{\partial\theta^2}+\frac{\partial w}{\partial\theta}\right)+\\
&f_{32}\frac{\partial\phi_{in}}{\partial\theta}+\bar{f}_{32}\frac{\partial\phi_{ex}}{\partial\theta}+\frac{b_{22}}{R}\frac{1}{R}\frac{\partial^2\psi_\theta}{\partial\theta^2}+\\
&\frac{k_s}{R}a_{44}\left(\psi_\theta+\frac{1}{R}\frac{\partial w}{\partial\theta}-\frac{v}{R}\right)\\
&+k_s l_{32}\frac{\partial\phi_{in}}{\partial\theta}+k_s\bar{l}_{32}\frac{\partial\phi_{ex}}{\partial\theta}=I_0\frac{\partial^2 v}{\partial t^2}+I_1\frac{\partial^2\psi_\theta}{\partial t^2},\\
&\delta w: k_s a_{55}\left(\frac{\partial\psi_x}{\partial x}+\frac{\partial^2 w}{\partial x^2}\right)+k_s l_{31}\frac{\partial^2\phi_{in}}{\partial x^2}+k_s\bar{l}_{31}\frac{\partial^2\phi_{ex}}{\partial x^2}+\\
&\frac{k_s a_{44}}{R}\left(\frac{\partial\psi_\theta}{\partial\theta}+\frac{1}{R}\frac{\partial^2 w}{\partial\theta^2}-\frac{1}{R}\frac{\partial v}{\partial\theta}\right)-\frac{b_{22}}{R}\frac{\partial\psi_\theta}{\partial\theta}\\
&-\frac{1}{R}f_{32}\phi_{in}-\frac{1}{R}\bar{f}_{32}\phi_{ex}=I_0\frac{\partial^2 w}{\partial t^2}-\Delta P,
\end{aligned}
$$

$$\delta\psi_x:\; b_{11}\frac{\partial^2 u}{\partial x^2}+d_{11}\frac{\partial^2\psi_x}{\partial x^2}+b_{12}\frac{1}{R}\left(\frac{\partial^2 v}{\partial x\partial\theta}+\frac{\partial w}{\partial x}\right)+\frac{d_{12}}{R}\frac{\partial^2\psi_\theta}{\partial x\partial\theta}+g_{31}\frac{\partial\phi_{in}}{\partial x}+\bar g_{31}\frac{\partial\phi_{ex}}{\partial x}+\frac{b_{66}}{R}\left(\frac{\partial^2 v}{\partial x\partial\theta}+\frac{1}{R}\frac{\partial^2 u}{\partial\theta^2}\right)+\frac{d_{66}}{R}\left(\frac{\partial^2\psi_\theta}{\partial x\partial\theta}+\frac{1}{R}\frac{\partial^2\psi_x}{\partial\theta^2}\right)-k_s a_{55}\left(\psi_x+\frac{\partial w}{\partial x}\right)+k_s l_{31}\frac{\partial\phi_{in}}{\partial x}+k_s\bar l_{31}\frac{\partial\phi_{ex}}{\partial x}=I_1\frac{\partial^2 u}{\partial t^2}+I_2\frac{\partial^2\psi_x}{\partial t^2},$$

$$\delta\psi_\theta:\; b_{66}\left(\frac{\partial^2 v}{\partial x^2}+\frac{1}{R}\frac{\partial^2 u}{\partial x\partial\theta}\right)+d_{66}\left(\frac{\partial^2\psi_\theta}{\partial x^2}+\frac{1}{R}\frac{\partial^2\psi_x}{\partial x\partial\theta}\right)+\frac{b_{12}}{R}\frac{\partial^2 u}{\partial x\partial\theta}+\frac{d_{22}}{R}\frac{1}{R}\frac{\partial^2\psi_\theta}{\partial\theta^2}+\frac{1}{R}g_{32}\frac{\partial\phi_{in}}{\partial\theta}+\frac{1}{R}\bar g_{32}\frac{\partial\phi_{ex}}{\partial\theta}-k_s a_{44}\left(\psi_\theta+\frac{1}{R}\frac{\partial w}{\partial\theta}-\frac{v}{R}\right)-k_s l_{32}\frac{\partial\phi_{in}}{\partial\theta}-k_s\bar l_{32}\frac{\partial\phi_{ex}}{\partial\theta}+\frac{d_{12}}{R}\frac{\partial^2\psi_x}{\partial x\partial\theta}+\frac{b_{22}}{R}\frac{1}{R}\left(\frac{\partial^2 v}{\partial\theta^2}+\frac{\partial w}{\partial\theta}\right)=I_1\frac{\partial^2 v}{\partial t^2}+I_2\frac{\partial^2\psi_\theta}{\partial t^2},$$

$$\delta\phi_{in}:\; l_{31}\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial\psi_x}{\partial x}\right)+l_{32}\left(\frac{\partial\psi_{\theta 1}}{\partial\theta}+\frac{1}{R}\frac{\partial^2 w}{\partial\theta^2}-\frac{1}{R}\frac{\partial v}{\partial\theta}\right)-f_{31}\frac{\partial u}{\partial x}-g_{31}\frac{\partial\psi_x}{\partial x}-f_{32}\left(\frac{1}{R}\frac{\partial v}{\partial\theta}+\frac{w}{R}\right)-\frac{1}{R}g_{32}\frac{\partial\psi_\theta}{\partial\theta}-p_{11}\frac{\partial^2\phi_{in}}{\partial x^2}-p_{22}\frac{\partial^2\phi_{in}}{\partial\theta^2}+p_{33}\phi_{in}=0,$$

$$\delta\phi_{ex}:\; \bar l_{31}\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial\psi_x}{\partial x}\right)+\bar l_{32}\left(\frac{\partial\psi_\theta}{\partial\theta}+\frac{1}{R}\frac{\partial^2 w}{\partial\theta^2}-\frac{1}{R}\frac{\partial v}{\partial\theta}\right)-\bar f_{31}\frac{\partial u}{\partial x}-\bar g_{31}\frac{\partial\psi_x}{\partial x}-\bar f_{32}\left(\frac{1}{R}\frac{\partial v}{\partial\theta}+\frac{w}{R}\right)-\frac{1}{R}\bar g_{32}\frac{\partial\psi_\theta}{\partial\theta}-\bar p_{11}\frac{\partial^2\phi_{ex}}{\partial x^2}-\bar p_{22}\frac{\partial^2\phi_{ex}}{\partial\theta^2}+\bar p_{33}\phi_{ex}=0$$

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$$\left[I_0,I_1,I_2\right]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}\rho_{\mathrm{P}}\left[1,z,z^2\right]dzd\theta+\int_0^{2\pi}\int_{-\frac{h}{2}}^{\frac{h}{2}}\rho(\mathrm{Z})\left[1,z,z^2\right]dzd\theta+\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}\rho_{\mathrm{P}}\left[1,z,z^2\right]dzd\theta,$$

$$\left[a_{11},b_{11},d_{11}\right]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}c_{11}\left[1,z,z^2\right]dzd\theta+\int_0^{2\pi}\int_{-\frac{h}{2}}^{\frac{h}{2}}\frac{E(z)}{1-\vartheta(z)^2}\left[1,z,z^2\right]dzd\theta+\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}c_{11}\left[1,z,z^2\right]dzd\theta,$$

$$\left[a_{12},b_{12},d_{12}\right]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}c_{12}\left[1,z,z^2\right]dzd\theta+\int_0^{2\pi}\int_{-\frac{h}{2}}^{\frac{h}{2}}\frac{\vartheta(z)E(z)}{1-\vartheta(z)^2}\left[1,z,z^2\right]dzd\theta+\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}c_{12}\left[1,z,z^2\right]dzd\theta,$$

درحالیکه

$$[a_{22},b_{22},d_{22}]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}c_{22}\left[1,z,z^2\right]dzd\theta+\int_0^{2\pi}\int_{-\frac{h}{2}}^{\frac{h}{2}}\frac{E(z)}{1-\vartheta(z)^2}\left[1,z,z^2\right]dzd\theta+\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}c_{22}\left[1,z,z^2\right]dzd\theta,$$

$$[a_{44},a_{55},a_{66}]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}\left[c_{44},c_{55},c_{66}\right]dzd\theta+\int_0^{2\pi}\int_{-\frac{h}{2}}^{\frac{h}{2}}\left[\frac{E(z)}{2(1+\vartheta(z))},\frac{E(z)}{2(1+\vartheta(z))},\frac{E(z)}{2(1+\vartheta(z))}\right]dzd\theta+\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}\left[c_{44},c_{55},c_{66}\right]dzd\theta,$$

$$b_{66}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}c_{66}zdzd\theta+\int_0^{2\pi}\int_{-\frac{h}{2}}^{\frac{h}{2}}\frac{E(z)}{2(1+\vartheta(z))}zdzd\theta+\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}c_{66}zdzd\theta,$$

$$[f_{31},g_{31}]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}2e_{31}\left(z+\frac{h+h_p}{2}\right)[1,z]dzd\theta,$$

$$[\bar{f}_{31},\bar{g}_{31}]=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}2e_{31}\left(z-\frac{h+h_p}{2}\right)[1,z]dzd\theta,$$

$$l_{31}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}e_{15}\left[\left(z+\frac{h+h_p}{2}\right)^2-\left(\frac{h_p}{2}\right)^2\right]dzd\theta,$$

$$\bar{l}_{31}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}e_{15}\left[\left(z-\frac{h+h_p}{2}\right)^2-\left(\frac{h_p}{2}\right)^2\right]dzd\theta$$

$$p_{11}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}k_{11}\left[\left(z+\frac{h+h_p}{2}\right)^2-\left(\frac{h_p}{2}\right)^2\right]^2dzd\theta,$$

$$p_{22}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}k_{22}\left(\frac{1}{r+z}\right)^2\left[\left(z+\frac{h+h_p}{2}\right)^2-\left(\frac{h_p}{2}\right)^2\right]^2dzd\theta,$$

$$\bar{p}_{22}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}k_{22}\left(\frac{1}{r+z}\right)^2\left[\left(z-\frac{h+h_p}{2}\right)^2-\left(\frac{h_p}{2}\right)^2\right]^2dzd\theta,$$

$$p_{33}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{-\frac{h}{2}-h_p}^{-\frac{h}{2}}4k_{33}\left(z+\frac{h+h_p}{2}\right)^2dzd\theta,$$

$$\bar{p}_{33}=\sum_{\gamma=1}^{N}\int_{(\gamma-1)(\beta_p+\beta_c)}^{\gamma\beta_p+(\gamma-1)\beta_c}\int_{\frac{h}{2}}^{\frac{h}{2}+h_p}4k_{33}\left(z-\frac{h+h_p}{2}\right)^2dzd\theta$$