ANALYSIS OF THE WELL WALLS STABILITY IN CONTROLLED DIRECTIONAL DRILLING

A.A. Saifullin

Scientific advisor - engineer Konoshonkin D.V.

National Research Tomsk Polytechnic University, Tomsk, Russia

The aim of this report is to identify the sections of the well, where the caving can happen under using the definite mud. Reaching these sections while drilling will indicate engineers that the drilling mud must be changed in order to prevent accidents and decrease the expenditures for drilling [1,2].

In the study the first step was to divide the problem into three simple parts according to the superposition method: wall deformation, drilling mud filtration and well bending.

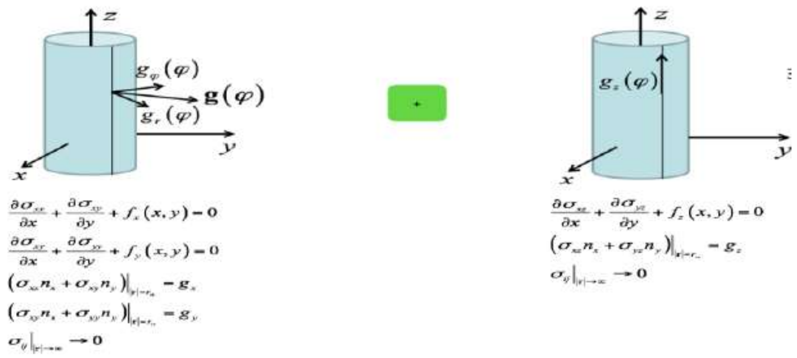

Fig. 1 Parts about wall deformation and well bending

Firstly, the two-dimension problem of wellbore wall deformation was solved in potential principles method, by means of solving the second part which related to well bending problem. Consequently, the issue becomes three-dimensional. Both tasks were solved within the radial coordinate system. This system was chosen because it will be more convenient to calculate stress tension in rounded shaped well.

$$\sigma_{rr} = \frac{1}{2}(\Sigma_1+\Sigma_2)\left(1-\left(\frac{R}{r}\right)^2\right)+\frac{1}{2}(\Sigma_1-\Sigma_2)\left(1-\frac{4R^2}{r^2}+\frac{3R^4}{r^4}\right)\cos 2\varphi + P\left(\frac{R}{r}\right)^2$$

$$\sigma_{\varphi\varphi} = \frac{1}{2}(\Sigma_1+\Sigma_2)\left(1+\left(\frac{R}{r}\right)^2\right)-\frac{1}{2}(\Sigma_1-\Sigma_2)\left(1+\frac{3R^4}{r^4}\right)\cos 2\varphi - P\left(\frac{R}{r}\right)^2$$

$$\sigma_{r\varphi} = -\frac{1}{2}(\Sigma_1-\Sigma_2)\left(1+\frac{2R^2}{r^2}-\frac{3R^4}{r^4}\right)\cos 2\varphi$$

$$\sigma_{zz} = \int_{h_1}^{h_2}\rho g dz$$

Fig. 2 Solution of the well deformation problem

$$\begin{cases} \sigma_{rz} = \left(1-\frac{r_w^2}{r^2}\sin 2\varphi\right)(\Sigma_1\cos^2\alpha+\Sigma_2\sin^2\alpha-\Sigma_3)\frac{\sin 2\beta}{2}+\left(1-\frac{r_w^2}{r^2}\cos 2\varphi\right)(\Sigma_1-\Sigma_2)\frac{\sin 2\alpha\sin\beta}{2} \\ \sigma_{\varphi z} = \left(1+\frac{r_w^2}{r^2}\cos 2\varphi\right)(\Sigma_1\cos^2\alpha+\Sigma_2\sin^2\alpha-\Sigma_3)\frac{\sin 2\beta}{2}+\left(1+\frac{r_w^2}{r^2}\sin 2\varphi\right)(\Sigma_1-\Sigma_2)\frac{\sin 2\alpha\sin\beta}{2} \end{cases}$$

Fig. 3 Solution of the well bending problem

After counting the stress tensor in every case, the general tenser was figured out and then transformed into the main stress tensor. The next step was to study the stability using the Coulomb-Mohr destruction [3] criterion and specially created C++ program. As a result of counting reliable boundary depths and drilling mud densities were obtained.

In conclusion, on the ground of calculated results, graphs were created which can be used for well construction recommendations.

References

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