1058-65-266 **Hengguang Li*** (hli19@syr.edu), Department of Mathematics, Syracuse University, Syracuse, NY 13244. *The FEM for axisymmetric elliptic PDEs.*

Let $\mathcal{L} := -r^{-2}(r\partial_r)^2 - \partial_z^2$. We consider the equation $\mathcal{L}u = f$ on a bounded polygonal domain with suitable boundary conditions, derived from the three-dimensional axisymmetric Poisson's equation. We establish the well-posedness, regularity and Fredholm results in weighted Sobolev spaces, for possible singular solutions caused by the singular coefficient of the operator $\mathcal{L}$, as $r \to 0$, and by non-smooth points on the boundary of the domain. In particular, our estimates show that there is no loss of regularity of the solution in these weighted Sobolev spaces. By analyzing the convergence property of the finite element solution, we provide a construction of improved graded meshes, such that the *quasi-optimal* convergence rate can be recovered on piecewise linear functions for singular solutions. The introduction of a new projection operator from the weighted space to the finite element subspace, certain scaling arguments, and a calculation of the index of the Fredholm operator, together with our regularity results, are the ingredients of the finite element estimates. (Received February 16, 2010)