Novel methods are needed to prevent or mitigate subsurface fluid leakage (for example stored carbon dioxide or fuels during unconventional oil & gas resource development or nuclear waste disposal). Ureolysis-induced calcium carbonate precipitation (UICP) has been investigated as a method to plug leakage pathways in the near-wellbore environment or in fractures. The enzyme urease catalyzes the hydrolysis of urea to react with calcium to form solid calcium carbonate (similar to limestone). UICP test specimens were prepared in triplicate by filling 2.5 cm x 5 cm and 5 cm x 10 cm cylindrical molds with sand and injecting both microbial and plant-based enzymes with urea and calcium solutions to promote precipitation. For comparison, Class H well-, Type I-Portland and fine cement specimens were prepared. Class H well- and Type I-Portland specimens were made by mixing the cement paste (AP10B) then mixing with sand (ASTM C305). Fine cement specimens were made both by mixing (AP10B and ASTM C305) and also injecting to match the process used to make the biocement specimens. For 2.5 cm x 5 cm specimens, compression strengths increased with the increase of CaC03 content. The strengths of the plant-based enzyme specimens reached 77% and 66% of the compressive strength of the 28-day well-cement and Type 1 cement mortars, respectively. The specimens also reached 83% of the 14-day fine cement strength. For 5 cm x 10 cm specimens, compression strengths of MICP (1st try), MICP, MICP (2nd try), ENICP, ENICP and EICP specimens reached 77%, 46%, 42%, 38%, 19% and 16% of the 28-day injected fine cement specimens. The highest modulus of elasticity, 18,475 ± 482 MPa, was obtained with the highest CaC03 content, 12.2 ± 1.6%, from MICP (JS' try) specimens. Modulus of elasticity of MICP, ENICP and MICP (2"d try) specimens were 17,316 ± 1,430 MPa, 16,623 ± 915 MPa and 15,080 ± 1,831 MPa with 8.3 ± 1.8%, 6.3 ± 0.64% and 4.9 ± 1.3% calcium carbonate content (g/g sand), respectively. The results of this study indicate that the UICP produced specimens may have adequate strength for field applications.